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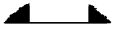
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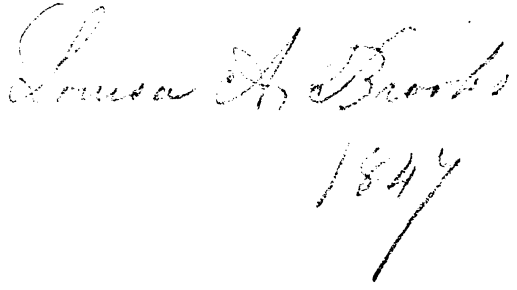
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Drawn by S. Page. A Black sc

He stooped down to pick up the horse shoe in his rage; but he suddenly let it drop, and roared out violently, and said that he was burned.

Page 15

New York, Harper & Brothers, 1836





HARRY AND LUCY,

WITH

OTHER STORIES,

by

MARIA EDGEWORTH.

IN TWO VOLUMES.

VOL. I.



Harry, who had been [illegible] this gave him courage, took the [illegible] up to the elephant and gave it to him.

NEW YORK.
Harper & Brothers.
1836.

HARRY AND LUCY:

WITH OTHER TALES.

BY

MARIA EDGEWORTH

IN TWO VOLUMES.

VOL. I.

NEW-YORK:

PUBLISHED BY HARPER & BROTHERS,
NO. 82 CLIFF-STREET.

1842.

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EARLY LESSONS.

HARRY AND LUCY.

PART FIRST.

HARRY AND LUCY.

PART I.

Little children who know the sounds of all letters can read words, and can understand what is told in this book.

Harry was brother to Lucy, and Lucy was sister to Harry. Harry had just come home to his father's house; he had been left at his uncle's when he was an infant, and had always lived at his uncle's house.

Lucy lay in a little bed in a closet near her mother's room; and Harry lay in a little bed in another closet.

Early in the morning, while Lucy was in bed, the sun shone through the window upon her face, and wakened her; when she was quite awake, she knew that it was morning, because it was daylight; and she called to her mother and said, "Mamma, may I get up?" But her mother did not answer her, for she did not hear what she said, because she was asleep: when Lucy knew that her mother was asleep, she lay still, that she might not disturb her, until she heard her mother stir; and then she asked her again if she might get up, and her mother said she might.

So Lucy got up, and put on her stockings and shoes, and finished dressing herself, and then went to her mother and asked for some breakfast. But her mother told her that she should make her bed before she should have any breakfast. Little Lucy began to make her bed, and her mother went into her other closet to waken Harry; and she said, "Harry, get up!" And Harry jumped out of bed in an instant, and put on his trousers, and his jacket, and his shoes; and then he combed his hair, and washed his hands; and, while he was wiping his hands, his mother went down stairs.

Little Lucy, hearing her brother Harry walking about in the closet, called him, and asked if he had made his bed? Harry said he had not. "Oh, then," says Lucy, "mamma will give you no breakfast."—"Yes," says Harry, "she will: I never made my bed at my uncle's, and I always had my breakfast."

As they were talking, he heard his father call him; and he ran down stairs to the parlour, where his father and mother were at breakfast; and her mother called Lucy down too, and said to her, "Well, Lucy, have you made your bed neatly?"

Lucy. Yes, mamma, I have made it as well as I could.

Mother. You shall have some breakfast then.

His father asked Harry whether he had made his bed. Harry answered that he did not know how to make it.

"I will show you," said his mother; and taking him by the hand, she led him up stairs, and showed him how to make his bed.

When Harry came down to his father, he said that he did not know that boys or men ever made beds; for, at his uncle's, nobody ever made beds but the housemaid.

His father told him that, in some countries,* the beds are made by men; and that in ships, which sail on the sea, and carry men from one country to another, the beds in which the sailors sleep are always made by men.

Lucy's mother observed that she had not eaten her breakfast; and she asked her why she had not eaten it.

Lucy said that she waited for her brother. Her mother then gave Harry a basin of milk, and a large piece of bread; and she set a little table for him and his sister, under a shady tree that was opposite to the open window of the room where she breakfasted.

* Here the child, if at a distance from the coast, should be told what is meant by different countries; what a ship is, and what is meant by a sailor, &c.

Lucy was a good little girl, and had always minded what was said to her, and had been very attentive, whenever her father or mother had taught her any thing. So her mother had taught her to read and to work; and when she was six years old, she could employ herself without being troublesome to anybody; she could work for herself and for her brother; and, sometimes, when Lucy behaved very well, her mother let her do a little work for her or for her father; and her mother had given her a little thimble to put upon her finger, and a little housewife to keep her needles and thread in, and a little pair of scissors to cut her thread with, and a little workbag to keep her work in; and Lucy's father had given her a little book to read in, whenever she pleased, and she could read in it by herself, and understand all she read, and learn every thing that was in it.

As soon as Lucy had eaten the breakfast which her mother had given her, she sat down on her stool, and took her work out of her workbag, and worked some time; then her mother told her that she had worked an hour, and that she did not choose that she should work any more: so Lucy got up and brought her work to her mother, and asked her if it was done as it ought to be done? And her mother said, "Lucy, it is done pretty well for a little girl that is but six years old; and I am pleased to see that you have tried to avoid the fault which I told you of yesterday:" then Lucy's mother kissed her, and said to her, "Put your work into your workbag, and put your workbag into its place, and then come back to me."

Lucy did as she was desired to do; and then her mother asked her if she would rather go out of doors and walk, or stay with her? Lucy liked best to stay with her mother, who very soon afterward went to her dairy.

Lucy followed her, and took a great deal of care not to be troublesome, for she loved to be with her mother; but she observed whatever she saw, and did not meddle with any thing. She saw that the dairy was very clean; the floor was a little damp, which made her think that it had been washed that morning; and there were not any cobwebs or dust upon the walls; and she perceived that the room smelt very sweet; she looked about to find out if there were any flowers that could make that pleasant smell, but she could not see any thing but a great many clean empty vessels of different shapes, and a great many round, wide, and shallow pans full of milk: she went near to them, and thought the smell came from them.

When she had looked at a good many of them, she thought they were not all alike; the milk in some of the pans was a little yellowish, and looked thick, like the cream that she saw every morning at her mother's breakfast; and the milk in the other pans was a little blue, and looked thin, like the milk that was often given to her and her brother to drink. While Lucy was thinking on this, she saw one of her mother's maids go to one of the pans that had the yellowish milk in it; and the maid had a wooden saucer in her hand, and she put the wooden saucer very gently into the pan; she did not put it down to the bottom of the pan, but took up that part of the milk which was at the top, and put it into another vessel; and then Lucy saw that the milk that was left in the pan was not at all like what the maid had taken out, but was very thin, and a little blue.

When Lucy's mother went out of the dairy, she took her little daughter out into the fields to walk with her. Soon after they set out, Lucy said, "Mother, when I was in your dairy just now, I saw the maid take some milk out of a milkpan, and it looked like what I see you put into your tea, and I believe it is called cream; but she left some milk in the pan, and that was not at all like cream, but like very thin milk; pray, mother, will you tell me why all that was in the pan was not cream?" Then her mother said, "Yes, Lucy, I will answer any questions you like to ask me when I have

leisure, because, whenever I talk to you, you mind what I say, and remember whatever your father or I teach you."

"I BELIEVE you know, that the kind of milk which I give you very often for your breakfast and supper, is taken out of the udders of cows. Did you never see the maids with milkpails going a milking? They were then going to take the milk from my cows: they call that milking them; and it is done twice every day, once in the morning, and once in the evening. When they have gotten the milk in the pails, they carry it into the dairy, and put it into such milkpans as you saw; and they let the milkpans stand still in the same place for several hours, that the milk may not be shaken; and in that time the heaviest part of the milk falls as low as it can towards the bottom of the pan, and the lightest part of the milk remains above it at the top of the pan; and that thick light part is called cream, as you thought it was. When the milk has stood long enough, the cream is taken from the other part of the milk; and doing this is called skimming the milk; but it must be done very carefully, or else the cream and milk would all be mixed together again." Lucy told her mother that, when she was in the dairy, she had walked all round it, and that she saw a great deal of cream more, she thought, than came every day into the parlour; and she wished to know what other use it was for except to mix with tea and fruit, or sweetmeats.

LUCY'S mother was going to answer her, but she looked towards the other side of the field, and said, "Lucy, I think I see some pretty flowers there; will you run and gather me a nosegay, before I talk any more to you?" Lucy said, "Yes, mother;" and ran away to do what her mother had desired. When she came to the place where the flowers were, she looked about for the prettiest, and gathered two or three of them; but, when she had them in her hand, she perceived that they had not any smell; so she went to a great many more, and at last she found some that had

a sweet smell, but they were not pretty; and she gathered some of them, and was taking them to her mother; but, as she passed near a hedge, she saw some honeysuckles growing in it; and she remembered that she had smelt honeysuckles that were very sweet, and they were very pretty too; so she was glad that she had found some, for she thought her mother would like them; but when she came close to the hedge, she saw that they were so high from the ground that she could not reach them. Lucy did not like to go away without taking some honeysuckles to her mother; so she walked slowly by the side of the hedge till she came to a place where there was a large stone, upon which she climbed, and gathered as many honeysuckles as she liked.

While she was getting down, she held the flowers fast for fear she should drop them into the ditch, and she felt something prick her finger very sharply; she looked, and she saw a bee drop down off one of the honeysuckles that she had squeezed in her hand: so she thought that she had hurt the bee, and that the bee had stung her to make her let him go, and that it was the bee which she had felt pricking her. Lucy was afraid that she had hurt the bee very much, for she remembered that when she opened her hand, the bee did not fly away, but dropped down; so she looked for it on the ground, and she soon found it struggling in some water, and trying with its little legs and wings to get out, but it was not strong enough. Lucy was very sorry for the bee, but she was afraid to touch it, lest she should hurt it again, or that it should hurt her. She thought for a little while what she could do; and then she got a large stalk of a flower, and put it close to the bee: as soon as ever the bee felt it, he clasped his legs round it, and Lucy raised the stalk, with the bee upon it, gently from the wet ground, and laid it upon a large flower that was near her. The bee was sadly covered with dirt; but as soon as he felt that he was standing upon his legs again, he began to stretch his wings, and to clean himself, and to buzz a little upon the flower. Lucy was glad to see that the bee did not seem to be very much hurt; and she took up her nosegay, and ran as fast as she could towards her mother; but the finger that the bee had stung began to be very sore.

She met her mother coming to her, who wondered what had made her stay so long; and when Lucy had told her what had happened, she said, "I thank you, my dear, for getting me so sweet a nosegay, and I am very sorry you have been hurt in doing it; I am sure you did not intend to hurt the poor little bee; and we will walk home now, and I will put some hartshorn to your finger, which will lessen the pain you feel."

Lucy said, "Indeed, mother, I did not mean to hurt the bee, for I did not know that it was in my hand; but when I am going to gather flowers another time, I will look to see if there are any bees upon them."

When Lucy's mother got home, some hartshorn was put to Lucy's finger, and soon after it grew easier; and Lucy's mother said to her, "Now I am going to be busy, and, if you like it, you may go into the garden till dressing time." Lucy thanked her, and said she did like it, but she hoped that some time, when she was not busy, her mother would answer what she had asked her about cream.

After breakfast, Harry's father took him out walking; and they came to a field where several men were at work; some were digging clay out of a pit in the ground; some were wetting what was dug out with water; and others were making the clay into a great number of pieces of the same size and shape. Harry asked his father what the men were about: and he told him that they were making bricks for building houses. "Yes," says Harry, "but I can run my finger into these; they are quite soft and brown, and the bricks of our house are red and hard, and they don't stick together as the bricks of your house do!" Saying this, he pushed down a whole hack of bricks. The man who was making them called out to desire he would pay for those he had spoiled. Little Harry had no money, and did not know what to do; but said to the man, "Indeed, sir, I did not intend to do any harm." The man answered, "Whether you intended any harm or not, you have spoiled the bricks, and must pay me for them; I am a poor man, and buy all the bread that I have with the

money that I get for these bricks; and I shall have less bread if I have a smaller number of bricks to sell."

Poor Harry was very sorry for what he had done, and at last thought of asking his father to pay for them; but his father said, "I have not spoiled them, and therefore it is not necessary that I should pay for them." The man, seeing that Harry had not intended to do mischief, told him, if he would promise to make amends at some future time for the mischief which he had done, he would be satisfied. Harry promised he would. "Now you find, Harry," said his father, "that you must not meddle with what does not belong to you."

As they walked on farther they came to a blacksmith's shop; and as it began to rain, Harry's father stood under the shed before the door; and a farmer came riding to the shop, and asked the blacksmith to put a shoe upon his horse, which, he said, had lost one a little way off, and which would be lamed if he went over any stony road without a shoe. "Sir," says the blacksmith, "I cannot shoe your horse, as I have not iron enough. I have sent for some to the next town, and the person whom I sent cannot be back before evening."

"Perhaps," said the farmer, "you have an old shoe that may be made to fit my horse."

The smith had no iron except a bit of small nail-rod, which was fit only for making nails; but he said that, if the farmer looked on the road, perhaps he might find the shoe which had fallen from his horse. Little Harry, hearing what had passed, told his father that he thought he could find a shoe for the farmer's horse. His father asked him where he thought he could find a shoe.

He said that he had observed something, as they walked along the road, lying in the dirt, which he thought was like a horseshoe. His father begged that the farmer would wait a little while; and then he walked back with Harry on the road by which they came to the blacksmith's, and Harry looked very carefully, and after some time he found the horseshoe, and brought it back to the smith's shop; but it was not fit to be put again upon the horse's foot, as it had been bent by a wagon-wheel which had gone over it.

The farmer thanked Harry; and the blacksmith said that he wished every little boy was as attentive and as useful. He now began to blow his large bellows, which made a roaring noise, and the wind came out of the pipe of the bellows among the coals upon the hearth, and the coals became red, and by degrees they became brighter and brighter, the fire became hotter, and the smith put the old iron horseshoe into the fire, and after some time it became red and hot like the coals; and when the smith thought that the iron was hot enough, he took it out of the fire with a pair of tongs, and put it upon the anvil, and struck it with a heavy hammer. Harry saw that the iron became soft by being made red-hot; and he saw that the smith could hammer it into whatever shape he pleased.

When the smith had made the shoe of a proper size and shape, he took a piece of nail-rod, and heated it redhot in the fire, by the help of the large bellows, which he blew with his left hand, while he held the tongs in his right.

Harry was going to examine the horseshoe that the smith had just made, but he would not meddle with it without leave, as he recollected what had happened in the brickfield.

While he was looking at the shoe, another little boy came into the shop; and, after lounging about for some time, he stooped down to pick up the horseshoe in his hand; but he suddenly let it drop, and roared out violently, and said that he was burnt. While he was crying, and blowing his fingers, and squeezing and pinching them to lessen the pain, the smith turned him out of the shop, and told him that if he had not meddled with what did not belong to him, he would not have been hurt. The little boy went away whimpering, and muttering that he did not know that black iron would burn him.

The smith now took the nail-rod out of the fire, and it was hotter than the other iron, and it was of a glowing white colour; and, when the smith struck it upon the anvil, a number of bright sparks were struck off the

iron, on every side, about the shop: they appeared very beautiful.

The smith then made some nails, and began to fasten the shoe on the horse's foot with the nails. Harry, who had never before seen a horse shod, was much surprised that the horse did not seem to be hurt by the nails which were driven into his foot; for the horse did not draw away his foot, or show any signs of feeling pain.

Harry's father asked him whether his nails had ever been cut.

Harry said that they had.

Papa. Did cutting your nails hurt you?

Harry. No.

Papa. A horse's hoof is of horn, like your nails; and that part of it that has no flesh fastened to it does not feel pain; the outside of the hoof may be cut, and may have nails driven into it, without giving any pain to the horse.

The blacksmith, who was paring the horse's foot, gave a piece of the horn that he had cut off to Harry, who perceived that it was neither so hard as bone, nor so soft as flesh; and the blacksmith told him that the hoof of a horse grows in the same manner as the nails of a man, and requires, like them, to be sometimes pared.

And when the blacksmith had finished shoeing the horse, he showed Harry the hoof of a dead horse, that was separate from the foot, and Harry saw how thick it was in that part where the nails were to be driven.

Harry's father now told him that it was time to go home, as they had two miles to walk, and it wanted but an hour of dinner-time. Harry asked his father how much time it would take up to walk two miles, if they walked as fast as they commonly did? and his father showed him his watch, and told him he might see, when they got home, how long they had been returning. Harry saw that it was four minutes after two o'clock, and when they got home it was forty-eight minutes after two; so Harry counted, and found how many minutes had passed from the time they left the blacksmith until they got home.

When Harry came into the garden, he ran to his sister Lucy, to tell her all that had happened to him; and she left what she was about, and ran to meet him. She thought he had been away a great while, and was very glad to see him; but just then the bell rang, and they knew they must go in directly, to make themselves clean before dinner.

When dinner was over, Harry and Lucy were let go into the garden; and then Lucy begged her brother to tell her all that had happened while he was out in the morning. Harry then told her how he had spoiled the bricks, and what the brickmaker said to him; and he told her that he had promised to make amends for the mischief he had done.

He told her that, to make bricks, men dug clay, and beat it with a spade, and mixed it with water, to make it soft and sticky, and that then they made it into the shape of bricks, and left it to dry; and when it was hard enough to be carried without breaking, it was put into large heaps and burnt, so as to become of a reddish yellow colour, and almost as hard as a stone.

"Then, brother," says Lucy, "if you will make some bricks, we can build a house in the little garden mamma lent me." So they went to the little garden, and Henry dug some earth with a little spade which his father had given him, and endeavoured to make it stick together with some water; but he could not make it sticky, like the clay that he saw the brickmakers use; and he ran in and asked his father why he could not make it sticky with water. And his father asked him whether it was the same kind of earth that he had seen at the brickfield. And Harry said he did not know what his father meant by the same kind of earth: he saw a man dig earth, and he dug it in the same manner.

Papa. But is the earth in the garden the same colour as that in the brickfield?

Harry. No: that in the garden is almost black, and that in the field is yellow.

Papa. Then they are not the same kinds of earth.

Harry. I thought all earth was alike.

Papa. You find that it is not; for you see that all earth cannot be made to stick together with water.

Harry went back into the garden; and, after having looked into a great many places for yellow earth, at last he saw some in the bottom of a hole that had been dug some time before; and he ran back and asked his father's leave to dig some of it; and, after he had gotten leave, he dug some of the yellow clay, and found that when it was mixed with water it became very sticky and tough; and that the more it was mixed, and squeezed, and beaten with the spade, the tougher it became. He now endeavoured to make it into the shape of bricks, but he found that he could not do it: and Lucy asked him whether the brickmakers were as long making a brick as he was. "No," said he; "they have a little box, made in the shape of a brick, without top or bottom, into which they put the clay upon a table, and with a straight stick, like a ruler, they scrape the clay even with the top of the box, and then, lifting up the box, they find the clay in the shape of a brick upon the table."—"Harry," said Lucy, "there is a carpenter in the house at work for my mother; I will go and ask her to get a box made for you: do you know by what name such a box is called, brother?"—"It is called a mould."

Lucy's mother let the carpenter make a brickmaker's mould for Harry; but the man could not begin until he knew what size it should be: how many inches long, how many inches broad, and how many inches thick it should be. Harry did not know what the carpenter meant; but Lucy, having always lived with her mother, who had been very kind to her, and who had taught her a great many things, knew what the carpenter meant; and as she wished to have bricks of the size of those with which her father's house was built, she went and measured some of the bricks in the wall; and, finding that a great many of them were all of the same length, she said to her brother that she supposed that they were all alike. Harry told her that, as the brickmakers used but one mould while he saw them at work, he supposed that they made a great number of bricks of the same size, and that the wall would not look so regular as it did if the bricks were of different sizes.

Lucy therefore thought, if she could measure one brick it would be sufficient. She easily found the length and the depth of a brick in the wall, but she did not at first know how to find the breadth, as the bricks lying upon each other prevented her from seeing their breadth; but Harry showed her, at the corner of the wall, that the breadth of the bricks could be seen: she measured very carefully, and found the length to be nine inches, the breadth four inches, and the depth two inches and a quarter. So the carpenter, when he knew the dimensions of the mould, made it; and Harry placed a flat stone upon two other large stones to serve for a table; and he and Lucy made several bricks; but they were a great while before they could make them tolerably smooth, as they stuck to the mould unless the mould was wetted. They were very happy making their bricks; but they did not know how they should burn them so as to make them hard, but they were determined to try.

It was eight o'clock in the evening before they had finished ten bricks, and they were called, and their mother gave them some bread and milk for supper, and sent them to bed.

The next morning Harry and Lucy got up as they did before; and their father and mother gave them leave to go and look at the bricks they had made; and Harry felt that they were a little harder than they were the night before; and Lucy thought that burning them would make them softer; for she had seen butter, and wax, and pomatum, and sealing-wax, all made soft by heat, but she did not remember to have seen any thing made hard by heat. But Harry put her in mind of the crust of pies, which is soft and tough like clay before it is baked, and which grows hard and brittle by the heat of the oven; and he told her that the iron of which the blacksmith made the horseshoe, when he blew the bellows, was hard and black before it was put into the fire, but that it became red when it was sufficiently heated, and so soft that the smith could hammer it into what shape he pleased.

Lucy believed what her brother said, but was resolved to beg that her mother would take her to see redhot iron, and a brick-kiln, which Harry told her was the name of the place in which bricks were burnt.

While they were eating the breakfast which their mother gave them, Harry asked his sister what she had been doing the day before, when he was out with his father; and Lucy told him all she had seen in the dairy, and when she was out a walking. When they had done breakfast, his mother lent Harry one of Mrs. Barbauld's little books for children, and let him read the story of the poor Blind Fiddler, with which Harry was very much pleased: and then she let Lucy read the following story.

A man, riding near the town of Reading, saw a little chimney-sweeper lying in the dirt, who seemed to be in great pain; and he asked him what was the matter; and the chimney-sweeper said that he had fallen down, and broken his arm, and hurt his leg, so that he was not able to walk: and the man, who was very good-natured, got off his horse, and put the chimney-sweeper upon it, and walked beside the horse, and held the boy on till he came to Reading; and when he came to Reading, he put the boy under the care of an old woman whom he knew there, and he paid a surgeon for setting his arm, and gave the woman money for the trouble which she would have in taking care of the boy, and the expense which she would be at in feeding him, till he should be able to work again to earn money for himself; and then the man continued his journey till he got to his own house, which was at a great distance. The boy soon got well, and earned his bread by sweeping chimneys at Reading.

Several years after that time, this same good-natured man was riding through Reading, and his horse took fright upon a bridge, and jumped, with the man upon his back, into the water; the man could not swim, and the people who were on the bridge, and saw him tumble in, were afraid to jump into the water to pull him out; but, just as he was ready to sink, a chimney-sweeper who was going by saw him, and, without stoping a moment, threw himself into the river, and, seizing hold of him, dragged him out of the water, and saved

him from being drowned: and when the man was safe upon the bank, and was going to thank the person who had pulled him out of the water, he recollected that it was the same chimney-sweeper whom he had taken care of several years before, and who had hazarded his own life to save that of his benefactor.

When Lucy had done reading, her mother asked Harry which he liked best, the man who had taken care of the chimney-sweeper whom he did not know, or the chimney-sweeper who had saved the life of the man whom he knew, and who had taken care of him when his arm was broken.

Harry said he liked the chimney-sweeper best, because he was grateful, and because he ventured his own life to save that of the man who had been kind to him: but Lucy said she liked the other man the best, because he was humane, and took care of a poor little boy who had nobody to take care of him, and from whom he could never expect to receive any benefit.

This is the history of Harry and Lucy for two days. The next Part will be the history of another day, when Harry and Lucy were a year older.

HARRY AND LUCY.

PART II.

After the summer was past, and after the autumn and winter were past, another spring came.

Harry and Lucy were now each of them a year older. And during the year that had passed, they were become taller and stronger, and had learned a great many things that they did not know before.

They had learned to read fluently; and they were therefore able to entertain themselves a little during the winter's evenings, with reading short stories in books which their mamma gave them; and they had learned a little arithmetic, and could cast up sums in addition, and subtract.

And they had each of them a little garden. Harry dug the ground when it was necessary, and Lucy pulled up weeds, and helped to wheel them away in her little wheelbarrow; and assisted in sowing seeds of different sorts, and in planting the roots of flowers.

In the summer she and Harry carried water to water the plants and flowers which they had set and sown in the spring. And they had not only planted flowers, and sown small salad, but Harry had also a crop of peas and a crop of potatoes in his garden; for his father had seen that he was industrious, and for that reason he gave him a piece of good ground to be added to his garden; and as it had been grass-ground for some time, it was so hard that Harry was not able to dig it. But his father had it dug roughly for him, and he had a cart-load of dung laid upon it. Harry had observed very attentively how his father's labourers had set potatoes; and in the beginning of the month of February he dug his ground over again, and marked it out into ridges, with stakes and a line, and spread the dung upon the ridges, leaving sufficient space between the ridges for the furrows. He then cut some potatoes which his father had given him into small pieces, to plant in the ground for sets. He took care to cut them so that

each piece should have an eye in it: that is to say, that each piece should have one of those little black spots in it which contain the root of the potato; for after the piece of potato has been some time in the ground, it rots away, and the root unfolds, and long fibres spread into the earth.

He scattered these pieces upon the dung, at eight or ten inches from each other; and then he dug earth out of the furrows that lay between the ridges, and covered the bits of potato and the dung with them, laying earth over them both to the depth of three or four inches.

When he had made any mistake, or had not done the work well, his father assisted him, and showed him how to do it better.

The rain in the following spring, and the heat of the sun in the beginning of summer, had contributed to the growth of Harry's crop, and in the middle of June he had some fine young potatoes fit to eat.

About this time of the year the weather is generally very hot; and one day, as Harry and his sister were sitting under the shady tree which was mentioned in the former chapter, picking some cowslips for their mamma, Harry observed that the shadow of the tree reached almost round the stem; and he had seen in the morning, when he was at breakfast, that the shadow of the tree fell only at one side of it. He asked his father, who was passing by, the reason of this; and his father took him to the door of the house, and desired him to look where the sun was; and he saw that it was opposite the door, and very high in the sky. "Take notice, Harry, where you see the sun now, and observe where you see it this evening when the sun is setting."

Harry said he knew where the sun set—that he could not see it from the hall door; but that he could see it from that end of the house which was at the right hand of the hall door as you go out.

Father. Did you ever observe where it rises?

Harry. Yes; it rose this morning at the other end of the house.

Father. It did so. Now do you know where are the south, and the north, and the east, and the west?

Harry. No: but I believe the side of the sky where the sun rises is called the east.

Father. It is so; and the side where it sets is called the west. Now you may always know the south and the

north, wherever you are, if you know where the sun either rises or sets. If you know where it rises, stand with your left hand towards that part of the sky, and then the part of the sky before your face will be the south, and that part of the sky behind your back will be the north.

In the same manner, if you know where the sun sets, turn your right hand towards that place, and the part of the sky opposite to you will be the south. But, Harry, you must remember that there are only two days in the year when the sun sets exactly in the west, and it rises exactly in the east.

Harry. What days are those, papa?

Father. It would be of no use to you to know the names of those days; but when one of them comes I will let you know it. On that day the sun rises exactly at six o'clock in the morning, and sets exactly at six o'clock in the evening.

"Papa," said Harry, "I have observed several times that my shadow in the morning and in the evening is very long, but in the middle of the day I can scarcely see my shadow."

Father. You must think about it yourself, Harry; for if I tell you every thing that you want to know, without your taking the trouble to think, you will not have the habit of thinking for yourself; and without being able to think for yourself, you will never have good sense.

The bricks which Harry and Lucy had made the year before, had all been *melted away* (as the workmen say) by the rain, or broken because they had not been burnt; but Harry had dug some tough yellow clay of a proper sort in the month of November, before the usual frosts of the winter had begun: and Harry mixed it well with the spade, and Lucy picked out the little pebbles with a small paddle, and the frost made the clay *mellow*, as the workmen call it. And in the spring Harry made nearly six hundred bricks, and built them into stacks, and covered them with turf, which his father had let him pare off the surface of the ground. And Harry's father, who had been much pleased with his good behaviour and industry, came to the tree where he was at work, and asked him if he would like to go to the brickfield, to see how

bricks were burnt. Lucy wished much to go with them, and she ran and asked her mother to let her go; her mother very cheerfully consented, and said she would go along with her.

While Lucy and her mother were getting ready to go, Harry ran to his garden, and dug some of his fine young potatoes, and put them into a basket which he had of his own, and returned to the house; and his father asked him what he intended to do with them.

"Sir," says Harry, "last year, when I had spoiled the poor man's bricks, I promised him that I would make amends; and I determined, when I set my potatoes, to let him have the first of them that were fit to be dug, as I was told that *early* potatoes were more valuable than those that *came in* later."

Father. But you will not be able to carry such a heavy load so far.

"I will try," said Harry.

He was able to proceed but a little way with his load without resting.

What could he do?

His father was willing to assist him, as he had shown honesty and truth in keeping his promise, and good sense in the means which he had taken to make the brickmaker amends for the injury which he had done to him. He asked a farmer whom he knew, and who was going by with a cart, to take the basket in his cart, and to leave it in the brickfield which was at the roadside.

By the time they had reached the brickfield to which they were going, and to which there was a pleasant walk through the fields, the farmer, who went by the road, had gotten with his cart to the same place.

Harry thanked him, took up his basket, and marched stoutly into the place where the brickmaker was at work.

The man knew him again, and was much pleased with Harry's punctuality. He took the potatoes out of the basket, and said that they were worth full as much as the bricks that had been spoiled.

Harry's father asked the man to shew him how he burnt his bricks to make them hard; and the man said he was just going to set fire to a kiln of bricks, and that he might see how it was done.

The kiln was made of the bricks that were to be burnt; these bricks were built up one upon another, and one beside the other, not quite close, but so as to leave a little room on every side of each brick; and in the middle of the kiln, near the bottom, there were large holes filled with furze bushes.

The whole kiln was as large as a large room; and the man went to his house for a few lighted coals, and he put them under the furze, which took fire and blazed, and the smoke came through the openings that were left between the bricks; and the heat of the fire came through them also, and heated the bricks; and the man told Harry's father that he should supply the kiln with furze, and keep the fire strong for six days and six nights, and that then the bricks would be sufficiently burnt.

Harry now said that he was afraid that he should not be able to build a kiln for his bricks; for he was now grown wise enough to know that it required time to learn how to do things which we have not been used to do. And he asked the brickmaker whether he thought he could build his bricks so as to be able to burn them. And the man told him that he believed he could not; but he said that on some holyday he would go to the place where Harry's bricks were, and would shew him how to build a nice little kiln, if Harry's father would give him leave.

Harry's father accepted this good-natured offer; and Harry plainly perceived that good conduct makes friends, and that a poor brickmaker may be of use even to persons who are not obliged to work for their bread.

While they were talking, Lucy was looking about and examining every thing in the brickfield; and she observed that at the farthest part of the field some white linen was stretched upon the grass to dry, and she saw several bits of black dirt lying upon the linen. They did

not stick to the linen, but were blown about by the wind, as they were very light.

Lucy picked up some of these black things; and when she showed them to her mother, her mother told her that they were bits of soot, which had been carried by the wind from the brick-kiln.

"But, mamma," said Lucy, "I don't see any chimney belonging to the brick-kiln; and soot, I believe, is always found in chimneys."

Mother. No, my dear, soot is smoke cooled; and wherever there is smoke there is soot. A great quantity of thick smoke rises from a brick-kiln; or, to speak more properly, a great quantity of smoke is carried upwards by the hot air that rises from a brick-kiln, and when this smoke cools, parts of it stick together, and make what we call soot, which falls slowly to the ground. This is some of it that has fallen upon the white linen; and you see it because it is black, and the linen upon which it has fallen is white.

Lucy. Why does it fall slowly?

Mother. Because it is light; if it were heavier, it would fall faster.

Lucy. What do you mean by light and heavy?

Mother. You cannot yet understand all that I mean by those words; but, if you take two things which are nearly of the same size in your hands, and if one of them presses downward the hand in which it is held more than the other does, that may be called heavy, and the other may be called light. You must observe, Lucy, that they can be called heavy or light only as compared together, or *weighed* in your hands; as, for instance, if you take a large wafer in one hand, and a wooden button-mould of the same size in the other, the button-mould will be readily perceived to be the heaviest; you might therefore say, that the button-mould is heavy, and the wafer is light.

But, if you were to take the button-mould again in one hand, and take a shilling in the other, you would call the shilling heavy, and the button-mould light. And, if you were to lay down the button-mould, and were to take a guinea into your hand instead of it, you would find the shilling would appear light when *compared* with the guinea.

Lucy. But, mamma, what do you compare the soot with when you say it is light?

Mother. I compare it in my mind with other things of nearly the same size, as bits of sawdust, or coaldust, or bits of gravel; but I cannot yet make you entirely understand what I mean. When you have learned the uses and properties of more things and their names, I shall be better able to answer the questions you have asked me upon subjects which I cannot explain to you now.

As they returned home, they saw a poor little girl crying sadly, and she seemed to be very unhappy. And Lucy's mother said to her, "Poor girl! what is the matter with you? What makes you cry so?"

"O madam," said the little girl, "my mother sent me to market with a basket of eggs, and I tumbled down, and the eggs are all broken to pieces, and I am sorry for it; for my mother trusted them to me, as she thought I would take care of them; and indeed I minded what I was about, but a man with a sack upon his back was coming by, and he pushed me, and made me tumble down."

Mother. Will your mother be angry with you when she knows it?

Little Girl. I shall tell my mother, and she will not be angry with me; but she will be very sorry, and she will cry, because she is very poor, and she will want the bread which I was to buy with the money for which I should sell the eggs; and my brothers and sisters will have no supper.

When the little girl had done speaking, she sat down again upon the bank, and cried very sadly.

Little Lucy pulled her mother's gown to make her listen to her; and then she said, softly, "Mamma, may I speak to the poor little girl?"

Mother. Yes, Lucy.

Lucy. Little girl, I have some eggs at home, and I will give them to you, if my mamma will let me go for them.

"My dear," says Lucy's mother to her, "our house is at a distance; and if you were to try to go back by yourself, you could not find the way; but, if the little girl will come to-morrow to my house, you may give her the eggs; she is used to go to market, and knows the road. In the meantime, my poor little girl, come

with me to the baker's at the top of the hill, and I will give you a loaf to carry home to your mother: you are a good girl, and tell the truth."

So Lucy's mother took the little girl to the baker's shop, and bought a loaf, and gave it to her; and the little girl thanked her, and put the loaf under her arm, and walked homeward very happy.

As he was going over a stile, Harry dropped his handkerchief out of his pocket, and it fell into some water, and was made quite wet; and he was forced to carry it in his hand until they came to a house, where his father told him he would ask leave to have it dried for him. And he asked the mistress of the house to let Harry go to the fire to dry his handkerchief. And while he held it at the fire, Lucy said she saw a great smoke go from the handkerchief into the fire; and her mother asked her how she knew it was smoke?

Lucy. Because it looks like smoke.

Mother. Hold this piece of paper in what you think like smoke, and try if you can catch any of those black things that were in the smoke you saw in the brick-field.

Lucy. No, mamma, it does not black the paper in the least; but it wets the paper.

Mother. Hold this cold plate in what you call smoke, that comes from the handkerchief.

Lucy. Mamma, I find the plate is wet.

Mother. What is it then, that comes from the handkerchief?

Lucy. Water. The water with which it was wetted when it fell into the ditch.

Mother. What makes the water come out of it?

Lucy. The heat of the fire, I believe.

Mother. At tea, to-night, put me in mind to show you water turned into steam, and steam turned into water.

When they had gotten home, Harry and Lucy went immediately, without losing any time, to cast up two sums in arithmetic, which they were accustomed to do every day.

Harry could cast up sums in common addition readily and Lucy understood the rule called subtraction: and

she knew very well what was meant by the words *borrowing* and *paying*, though it is not easy to understand them distinctly. But she had been taught carefully by her mother, who was a woman of good sense, and who was more desirous that her daughter should understand what she did, than that she should merely be able to go on as she was told to do without knowing the reason of what she was about.

And after they had shown the sums which they had cast up to their mother, they sat down to draw.

Lucy was learning to draw the outlines of flowers; and she took a great deal of pains, and looked attentively at the print she was copying. And she was not in a hurry to have done, or to begin another flower; but she minded what she was about, and attended to every thing that her mother had desired her the day before to correct. And after she had copied a print of a periwinkle, she attempted to draw it from the flower itself, which she had placed in such a manner as to have the same appearance as the print had, that she might be able to compare her drawing from the print with her drawing from the flower.

She found it was not so easy to draw from the latter as from the former; but every time that she tried it became easier. And she was wise enough to know that it was better to be able to draw from things themselves, or from nature, as it is called, than from other drawings; because everybody may everywhere have objects before them which they may imitate; and, by practice, they may learn to draw or delineate objects so well, as to be able to express upon paper, &c., to other people, whatever curious things they meet with.

The habit of drawing is particularly useful [illegible]

learn to draw flowers. He was endeavouring with great care to trace a map of the fields about his father's house. He had made several attempts, and he had failed several times; but he began again, and every time improved.

He understood very well the use of a map; he knew that it was a sort of picture of ground, by which he could measure the size of every yard, or garden, or field, or orchard, after it had been drawn upon paper, as well as it could be measured upon the ground itself. He could also draw a little with a rule and compasses; he could describe a circle, and make an equilateral triangle, and a right angle; and he had begun to learn to write.

After they had drawn and written for one hour, it was time for them to go and dress before dinner.

Harry's walk to the brickfield had made him very hungry, so that he ate heartily.

While he was eating, his mother told him that she intended to send him into the garden, after dinner, for some strawberries, that were just ripe; and she advised him not to eat so much pudding if he wished to eat strawberries.

Now Harry had learned from experience, that if he ate too much it would make him sick; he therefore prudently determined not to have another spoonful of pudding.

A little while after dinner, Harry and Lucy went with their mother into the garden; and Lucy was desired to gather six strawberries, and Harry was desired to gather four strawberries. And when they were put together, Harry counted them, and found that they made ten. Lucy was not obliged to count them, for she knew by rote, or by heart, as it is sometimes called, that six and four make ten.

Each of them next brought five strawberries: and Harry knew, without counting, that, when they were put together, they would make ten. And Lucy knew that the parcel of strawberries which they gathered first, which made ten, would, when added to the second parcel, which also consisted of ten, make twenty.

They now went and gathered ten more. One gathered three, and the other gathered seven; and this ten, added to the former number, made thirty. And they went

again, and brought ten more to their mother; this ten was made up of eight and two; and this ten, added to the thirty they had gathered before, made forty.

While they were eating them, Harry asked his sister if she knew what was meant by *ty* in twenty and thirty. Lucy laughed at him for supposing that she did not know it, and said her father told her. Harry said that he knew before that *teen*, in the words thirteen, &c., meant ten; but he did not know that *ty*, in twenty, and thirty, &c., meant ten. And he said he did not know why ten should have three names, ten, teen, and ty.

Lucy said she could not tell; but they asked their father, and he told them, that *ten* meant ten by itself, without any other number joined to it; but that *teen* meant ten with some other number joined to it; and he asked Harry what thirteen meant.

Harry. I believe that it is three and ten; for three joined or added to ten make thirteen. Fourteen is plainly four and ten; fifteen five and ten. But why, papa, is it not three-teen, instead of being called thirteen?

Papa. Because it is easier to say thirteen than three-teen.

Lucy. But why is it called twelve? It should be two-teen.

Harry. And eleven, papa, should be one-teen.

Papa. I cannot now explain to you, my dear, the reason why we have not those names in English; but you perceive that it is easy to remember the names of fourteen, fifteen, sixteen, &c., because we remember that four, five, six, come after one another, and we perceive that all that is necessary is, to add *teen* to them. You see that fourteen means four and ten—four added to ten.

Harry. But does *ty* in forty mean four added to ten?

Lucy replied, that it did not.

Papa. No—it means four times ten: not ten added to four, but ten added together four times—and fifty means ten added together five times. So, you see, that it is useful to have three names for ten, which differ a little from one another, but which are also something like each other; for teen is like ten, and ty is like teen.

Teen is always used when ten is added to any number, as far as nineteen; and ty is always used when more tens than one are counted, as far as a hundred.

Harry. Then twenty should be two-ty; and thirty should be three-ty.

Papa. I told you before, my dear, that thirteen is used instead of three-teen, because the former word is more easily pronounced than the latter. Thirty is used instead of threety, for the same reason.

Harry. But why is not twenty two-ty?

Papa. Twenty is made up of ty and of twain, a word that was formerly used for two: the word twain joined to ty, makes twainty, which, when spoken quickly, sounds like twenty.

Harry. But, papa, will you tell me another thing?

Papa. No, Harry; we have talked enough about numbers at present; you will be tired by thinking any longer with much attention, and I do not wish that you should be tired when you attend to what you are about. Thinking without tiring ourselves is very agreeable; but thinking becomes disagreeable if we tire ourselves; and as thinking with attention is useful and necessary, we should take care not to make it disagreeable to ourselves.

It was now teatime, and Harry and Lucy usually supped at the same time that their father and mother drank tea: so that they had an opportunity of hearing many useful and entertaining things that passed in conversation; and Lucy, recollecting that her mother had promised to tell her, at teatime, something more about smoke and steam, put her in mind of what she had promised. Then her mother called for a lighted wax candle, and for a lighted tallow candle; and she desired Lucy to hold a cold plate over the wax candle, and Harry to hold another cold plate over the tallow candle; and in a short time a considerable quantity of smoke, or soot, was collected upon each of the plates. Another cold plate was held over the tea-urn, in which water was boiling, and from which there issued a large quantity of steam, or vapour of water. This steam was stopped by the plate, which, by degrees, was covered with a number of very small drops, not so large as the head of a minikin pin. After the plate had been held

over the steam a little longer, these drops became larger —they attracted one another; that is to say, one little drop was joined to another and made a large drop; and so on, till at length the drops ran so much together as to lose their round shape, and to run over the plate. Harry and Lucy were much entertained with this experiment. Harry observed that the vapour of water was very different from the vapour of a candle.

Papa. I am very glad to find that you have so readily learned something of the meaning of the word vapour, which I have purposely made use of in the place of the word steam; but you are mistaken, my dear, in saying vapour of a candle. Lampblack, soot, and smoke, are formed from the vapour of the oily part of burning bodies. Formerly, in England, people made use of lamps instead of candles, and the soot of those lamps was called lampblack, though it should properly be called oilblack. Now, pray, Harry, do you know the meaning of the word evaporate?

Harry. I believe it means being turned into vapour.

Papa. Did you observe any thing else in the experiments which I have just shown to you?

Harry. Yes, papa—I saw that the vapour of oil was solid when it was cold.

Papa. Condensed.

Harry. Yes, condensed.

Papa. And did you not observe that the vapour of water, when condensed, was fluid? And what did you observe, Lucy?

Lucy. I thought, papa, that the soot, or lampblack, which you told me was the vapour of oil, did not seem to turn into oil again when it was condensed, but that it had entirely a different appearance from the tallow and wax from which the oil came; and yet that the vapour of water, when it was condensed, became water again.

Papa. I do not think, my dear children, that my time has been thrown away in showing you this experiment. And as I wish to make you like to attend to what is taught to you, I will endeavour to make it agreeable to you by joining the feeling of pleasure to the feeling of attention in your mind,—by giving you pleasure, or the hope of pleasure, when you attend.

Harry. I know what you mean, papa; for, if we had not attended to what we were about, you would have endeavoured to give us pain.

Papa. No, Harry, you are a little mistaken. I don't wish to give you pain unless when I want to prevent you from doing something that would be hurtful to yourself or to other people; and then I wish to associate, that is, join pain, with such actions. But I do not expect that little boys and girls should be as wise as men and women; and if you do not attend, I only abstain from giving you pleasure.

Harry. But, papa, what pleasure were you going to give us?

Papa. I was not going to give you any immediate or present pleasure, but only the hope of some pleasure to-morrow. Your mamma and I intend to-morrow to walk to breakfast with her brother, your uncle, who has come to live at a pretty place not quite three miles from this house. He was formerly a physician, and he has several curious instruments—a microscope, an electrifying machine, an airpump, and a collection of fossils, and a few shells and prints: and he knows very well how to explain things to other people. And the pleasure that your mamma and I meant to give you was, to take you with us to-morrow morning. Harry and Lucy were very happy when they were going to bed, from the remembrance of the day that they had passed, and from the hope of being happy on the day which was to come.

At six o'clock in the morning Harry wakened; and, as they were to set out for Flower Hill at seven, he got up, and dressed himself with great alacrity; and Lucy did the same. But alas! their hopes were disappointed; for a violent thunder-storm came on before seven o'clock, which prevented their walk to their uncle's.

Harry planted himself at the window, and examined every cloud as it passed by, and every quarter of the sky, in expectation of fair weather and sunshine; but his sister, who was older, knew that her standing at the window would not alter the weather; and she prudently sat down to study botany before breakfast, and to examine some flowers which she had gathered in her walk the day before.

When Harry had stood some time at the window, and had seen no appearance of a change in the sky, he turned about, and looked wistfully round him, like a person

who did not know what to do with himself. His mother, who at that instant came into the room, could not help smiling at the melancholy figure which she saw before her; and she asked Harry what was the matter. Harry owned that he felt sorry and sad, because he had been disappointed of the pleasure which his father had promised him.

Mother. But, Harry, my dear, your father did not promise you fine weather.

Harry (*laughing*). No, mamma, I know he did not; but I expected that it would be a fine day, and I am sorry it is not.

Mother. Well, Harry, that is all very natural, as it is called; or, to speak more properly, it is what happens commonly. But though you cannot alter the weather, you may alter your own feelings, by turning your attention to something else.

Harry. To what else, mamma?

Mother. You have several different occupations that you are fond of; and if you turn your thoughts to any of them, it will prevent you from feeling sad upon account of the disappointment that you have met with. Besides, my dear Harry, the rain must, in some respects, be agreeable to you, and it is certainly useful.

Harry. O yes, mamma, I know what you mean—my garden. It was indeed in great want of water, and it cost me a great deal of trouble to carry water to it twice every day. My peas will come on now, and I shall have plenty of radishes. Thank you, mamma, for putting me in mind of my garden; it has made me more contented.

Harry's father now came in; and seeing that he was cheerful, and that he bore his disappointment pretty well, he asked him if he had ever seen a cork garden.

Harry. No, papa; I remember I have seen a cork model of a house; but I never saw the model of a garden made of cork.

Papa. But this is not the model of a garden, but a sort of small garden made upon cork. Here it is.

Harry. Why, this is nothing but the plate or saucer that commonly stands under a flower-pot, with a piece of cork, like the bung of a barrel, floating in water.

Papa. Notwithstanding its simplicity, it is capable, to a certain degree, of doing what a garden does. It can produce a salad. Here are the seeds of cresses and

mustard; sprinkle them thinly upon this cork, and lay it in the closet near the window that is towards the south.

Harry. When may I look at it again?

Papa. Whenever you please. But do not touch or shake it; for, if you do, it will disturb the seeds from the places where they now rest, and that will prevent them from growing. In two or three days you will see that cresses and mustard-plants have grown from these seeds.

Harry. Pray, papa, will the seeds grow on the cork as they grow in the ground?

Papa. No, my dear; it is not the cork that nourishes the plant, but it is the water which makes it grow. If you cover the bottom of a soup-plate with a piece of flannel, and pour water into the plate so high as just to touch the flannel, and scatter seeds on the surface of the flannel, they will grow upon it in the same manner that they grow upon cork.

Harry. But if it is by the water only that the seeds are made to grow, would they not grow as well if they were put upon the bottom of the plate without any cork or flannel?

Papa. No, my little friend, they would not; because, if there were only so much water in the plate as to cover only half of each of the seeds, it would be so shallow as to be evaporated (you know what that means, Harry) before the seeds could grow. Perhaps, also, the surface of the plate may be so smooth as to prevent the fibres of the roots from taking hold of it. And there are many more reasons which occur to me why it is probable they would not grow.

Harry. But we can try, papa.

Papa. Yes, my dear, that is the only certain method of knowing.

Lucy's mother recollected that she had promised her the last year to show her how butter was made; and as the rain in the morning had prevented Lucy from going to her uncle's, her mother thought it would be a good time to take her into the dairy, where the dairy-maid was churning. Little Harry was permitted to go with his sister.

They remembered the wide shallow pans which they

had seen the year before; and they recollected that the cream, or oily part of the milk, which was the lightest, separated itself from the heaviest part; or, to speak more properly, that the heaviest part of the milk descended towards the bottom of the pans, and left the cream, or lightest part, uppermost; and that this cream was skimmed off twice every day, and laid by, till a sufficient quantity, that is to say, five or six, or any larger number of quarts, was collected.

They now saw twelve quarts, or three gallons of cream, put into a common churn; and the dairy-maid put the cream in motion by means of the churn-staff, which she moved up and down with a regular motion for seven or eight minutes: when she appeared tired, another of the maids took the churn-staff from her, and worked in her stead; and so on alternately for about three quarters of an hour, when the butter began to come, as it is called, or to be collected in little lumps in the cream. Harry and Lucy were much surprised, when the lid or cover of the churn was taken off, to see small lumps of butter floating in the milk. They saw that the cream had changed its colour and consistence, and that several pieces of butter were swimming on its surface. These pieces of butter were collected and joined together into one lump by the dairy-maid, who poured some cold water into the churn to make the butter harder, and to make it separate more easily from the milk, which had become warm with the quick motion that had been used to make the butter come. Then she carefully took it all out of the churn, and put it into a wooden dish, and pressed and squeezed it so as to force all the milk out of it. She then washed it very clean in cold water a great many times; and, with a wooden thing called a slice, which is like a large flat saucer, she cut the lump of butter she had made into pieces, in order to pull out of it all the cow's hairs that had fallen into the milk of which the cream had been made.

Many of those hairs stuck to the slice, and others were picked out as the butter was cut in pieces. The butter was then well washed, and the water in which it had been washed was squeezed out of it. The butter was now put into a pair of scales, and it weighed nearly three pounds. Some of it was rolled into cylinders of about half a pound weight each, and some of it was made into little pats, and stamped with wooden stamps, which

had different figures carved upon them, the impression of which figures was marked upon the butter.

Lucy asked what became of the milk, or liquor, which was left in the churn; her mother told her it was called buttermilk, and that it was usually given to the pigs.

Lucy. Mamma, I have heard that in Ireland and in Scotland the poor drink buttermilk, and are very fond of it.

Mother. Yes, my dear; but the buttermilk in Ireland is very different from the buttermilk here. We separate the thick part of the cream from the rest for the purpose of making butter; but in Ireland, they lay by the thinner part, which is only milk, as well as the thick cream for churning, and they add to it the richest part of the new milk, which is what comes last from the cow when she is milked: and what is left after the butter is made is for this reason not so sour, and is more nourishing than the buttermilk in this country.

Lucy. Do not they sometimes make whey of buttermilk and new milk?

Mother. Yes, my dear; whey is made of buttermilk and skimmed milk; but it is not thought so pleasant or useful in England, though it is much liked in Ireland; probably because the buttermilk here is not so good as it is in Ireland. I am told that it is frequently preferred in that country to any other kind of whey, even by those who are rich enough to have wine whey. You see, my dear Lucy, that small circumstances make great differences in things. I have heard it said that the Irish poor must be very wretched indeed if they be forced to use buttermilk instead of milk; but, the fact is, their buttermilk is so much better than ours, that they frequently prefer it to new milk. To judge wisely, we must carefully make ourselves acquainted with the facts about which we are to judge.

Harry. Pray, mamma, why does dashing about the milk with the churn-staff make butter?

Mother. The process of making butter is not exactly understood. Cream consists of oil, whey, and curd, and an acid peculiar to milk. You know what is meant by an acid?

Lucy. Not very well; I know it means what is sour.

Mother. Yes, my dear, sourness is one of the properties of acids; and when you have acquired a knowledge of a greater number of facts, that you can compare with

one another, I shall be better able to explain to you what is meant by many terms that I cannot at present make you understand.

Harry. But, mamma, you have not told us why churning makes butter.

Mother. My dear, it does not make butter; it only separates the oily or buttery parts of the cream from the curd, or cheesy part, and from the whey. We do not know exactly how this is done by churning; but it is probable that, by striking the cream with the churn-staff, or by shaking it violently, the oily parts or particles are from time to time forced nearer together, which enables them to attract each other.

Harry. Yes, mamma, I know what that is—just as globules of quicksilver run together when they are near enough.

Mother. Globules! Harry, where did you find that new word?

Harry. Papa told it to me the other day when I was looking at some quicksilver that he had let fall. He told me the little drops of quicksilver, or mercury, which look like balls, were called globules, or little globes.

Lucy. And, mamma, the drops of dew and rain stand on several leaves separate from one another. On a nasturtium-leaf I have seen drops of water almost as round as drops of quicksilver, and when I pushed two of the drops near one another, they ran together and formed one large drop.

Mother. They were attracted together, as it is called.

Lucy. But the larger drop, which was made of the two drops, was not twice as large as either of the two small ones.

Mother. Are you sure of that, Lucy?

Lucy. No, mamma, but I thought so.

Mother. Two drops of mercury of the same size, or two drops of any other fluid, when they join, do not form a drop that is twice as large in breadth or diameter as one of the small drops, but such a drop contains exactly as much, and weighs as heavy, as the two small drops.

Harry. I do not understand you, mamma.

Mother. I will, by degrees, endeavour to make you understand me; but it cannot be done at once, and you have attended enough now. Lucy, it is time to read—let us go on with the account of the insects which you were reading yesterday.

Then Lucy, and Harry, and their mother, left the dairy, and returned to the drawing-room.

Mother. Here, Harry, sit down and listen to what your sister reads. You will soon be able to read to yourself without assistance, which, in time, will become an agreeable employment.

Lucy now read in the Guardian, No. 157, a very entertaining account of the industry and ingenuity of ants.

Both Harry and she wished much that they could find some ants' nests, that they might see how they carried on their works. Their mother said that she could show them an ants' nest in the garden; and, as it had done raining, she took them into the garden, and showed them two little holes in the ground, where the ants had formed cells, which served them for houses to live in, and for storehouses to keep their eggs and food. They were busily employed in making a road, or causeway, from one of these holes to the other. Great numbers were employed in carrying earth to repair breaches, which had been made in their work by the rain.

Harry laid some dead flies, and some small crumbs of bread, upon the track where the ants were at work; but they were not diverted from their labour by this temptation: on the contrary, they pushed the dead flies and the crumbs out of their way, and went steadily on with their business. Harry's mother told him she had tried the same experiment before, and that, perhaps, another time, the ants might choose to eat instead of pushing away the food that was offered to them.

Harry and Lucy stayed patiently watching the ants, till it was time to dress for dinner.

After dinner, Harry's father told him that the weather was sufficiently fine for their jaunt to Flower Hill: and Harry now saw, that it was not such a great misfortune as he had thought it in the morning, to have his walk deferred; and he and Lucy set out joyfully with their father and mother, to go to see their uncle.

Their way was through some pretty fields, and over stiles, and through a wood, and along a shady lane. As they passed through the fields, Harry, when they came to a cornfield, was able to tell the name of the grain which was growing in it; and Lucy told him the names of several of the wild flowers and weeds which were growing among the corn, and under the hedges.

During the last year, Harry had learned to be very

active in body as well as in mind; and when he came to a low stile, he put his hands upon the top rail, and vaulted nimbly over it. And Lucy ran almost as fast as her brother, and was very active in every exercise that was proper for a little girl.

They soon came to a windmill, which went round with great quickness. It was not necessary for his father to warn Harry not to go too near the arms or sails of the windmill, as he had read, in a "*Present for a Little Boy*," how dangerous it is to go within the reach of a windmill's sails. He was not, however, foolishly afraid, but wisely careful. He kept out of the reach of the sails, but he was not afraid of going to the door, or to the wheel and lever by which the top was turned round; and he counted, with the assistance of his father, the number of turns which the sails made in a minute.

His father looked at his watch during one minute; and Harry counted the number of revolutions or turns that the sails made in that time. He found that they went round forty-five times in a minute.

Lucy observed that the middle of the sails moved round through a very small space, but that the ends or tips of them went very fast.

Papa. My dear, you see a black spot in that part of the cloth of the sails which is near the centre of the arms, goes as often round as the tips of the sails—what, then, do you mean by saying that the tips move very fast?

Lucy. I mean, that they go a great way in a little time.

Papa. What do you mean by a great way?

Lucy. I am afraid that I cannot explain myself clearly—I mean, that the tips of the windmill sails go through a great way in the air—I believe I should say, that they describe a very large circle, and the part of the sails that are near the centre describe a small circle.

Papa. Now I understand you distinctly; the circle which the tips describe is very large, *when compared* with that described by the part near the centre. I have tried several times how fast the tips of windmill sails move; and, when there was a brisk wind, they moved a mile in a minute.

Harry. That is very fast indeed. But how could you tell this, papa?

Papa. I cannot explain to you now, but some time hence I will.

They now went through a wood, where they saw squirrels jumping from tree to tree with great agility; and rabbits, sitting up on their hind legs, looking about them, and running from one hole to another, as if they were at play. Harry asked several questions about the squirrels and rabbits, and about woodpeckers and other birds that he saw. By these means, he and Lucy got some knowledge in their walk, and were amused the whole way to their uncle's.

Harry. Papa, this walk puts me in mind of "Eyes and no Eyes," in Evenings at Home. I feel very glad to find that things which I have read in that book are like real things, and that what I have read is of use to me.

Neither Lucy nor Harry had ever seen their uncle B——; and they expected, as he was called Doctor, that he must be a very grave old man, who would not take the trouble to talk to little children: but they were much mistaken: for they found that he was very cheerful, and that he talked to them a great deal. After tea he took them into his study, in which, besides a great many books, there were several instruments and machines of different sorts.

They had both seen a barometer and thermometer at home; but the barometer at Doctor B——'s was much larger than what Harry had seen before; and it was not fixed up against the wall, but was hung upon a stand with three legs, in such a manner that, when it was touched, it swung about; and the shining quicksilver within-side of it rose and fell, so as to show that it did not stick to the tube which contained it. There were an airpump, and a microscope, and a wooden orrery in the room, and a pair of very large globes.

Doctor B—— let Harry examine them: and he was so good as to answer all the questions that either Lucy or Harry asked him.

Harry asked him what that shining liquid was which he saw in the tube of the barometer.

Doctor B——. It is a metal called quicksilver; and it is found in mines under ground.

Harry. My papa showed me quicksilver the other day, and it was liquid, and was spilt on the table and on the

floor; and how can that be a metal? I thought metals were all solid.

Doctor B——. So they are all when they are sufficiently cold.

Harry. Then is quicksilver hotter than iron?

Doctor B——. I cannot explain to you at present what you want to know.

Harry. What is that globe made of?

Doctor B——. Of pasteboard and plaster.

Harry. How is it made round? I thought pasteboard was made of flat sheets of paper, pasted upon one another.

Doctor B——. Flat pasteboard is; but the pasteboard upon this globe is made round by means of a round mould, upon which it is formed. You know, I suppose, what a mould is?

Harry. Yes, I do, pretty well. But how can the pasteboard, after it is all pasted together, be gotten off a round mould?

Doctor B——. After it is dry it is cut all round with a knife; and then it will come off the mould in two caps, as the shell of a nut, when it is opened with a knife, comes off the kernel.

Harry. What is the use of this machine which you call an airpump?

Doctor B——. To pump air out of that glass vessel which you see.

Harry. I do not quite understand you, sir.

Doctor B——. No, my dear, it is not probable that you can; but I will soon give you a little book, which will teach you the uses of several instruments of this sort.

Harry. My dear uncle, I cannot tell you how much I should be obliged to you.

Harry and Lucy were much delighted with what they saw at their uncle's; and, as they had not been troublesome, he asked their father and mother to bring them to Flower Hill when they came next to see him.

They returned home that evening just before it was dark, and went to bed by moonlight.

Thus ends an account of three days passed by Harry and Lucy. One day when Harry was about five, and Lucy six years old; and two days a year afterward, when Lucy was seven, and Harry six years of age.

HARRY AND LUCY.

BY

RICHARD LOVELL EDGEWORTH

AND

MARIA EDGEWORTH.

La philosophie a des discours pour la naissance des hommes, comme pour la décrépitude. Prenez les simples discours de la philosophie; sachez les choisir et traiter à point, ils sont plus aisés à concevoir qu'un conte de Boccace. Un enfant en est capable au partir de la nourrice, beaucoup mieux que d'apprendre à lire ou à écrire.

TO PARENTS.

We are afraid that the following pages should appear too difficult for children of eight or ten years old, if their thoughts have not been turned to subjects of the sort which are here introduced to their attention. We therefore most earnestly deprecate the use of the following book, till the understandings of the pupils into whose hands it may be put shall have been previously accustomed to the terms and to the objects which are mentioned in the following part of this little volume.

The intention of the writers is to prepare the mind for more difficult studies; and the end which they have in view will be completely frustrated, if this little book is *crammed* into the minds of children. It is intended to be used in very short portions, and not to be formed into necessary tasks; but to be read when the child's mind has been prepared, by what it has already seen and heard, to wish to see more.

That these *lessons* (not *tasks*) are in themselves intelligible to children, we are certain; because they have been readily comprehended by several young children, and in particular by a boy of four years and two months old. All the experiments herein related were shown to him at different times within a fortnight. He was much entertained. His lessons were short, but his attention was engaged, and he seemed to wish for their return with eagerness. That he did and does understand them thoroughly, and that he has not been taught certain answers to certain questions by rote, we assert. In making this assertion, we do not mean to claim any superiority for this child over other children; because we believe him to be no prodigy, but a child of good abilities, without any peculiar cleverness. So far from making any such claim, we must acknowledge that this boy scarcely knows his letters, and that he shows no extraordinary quickness in learning them. He is, however, lively and obedient; indeed, the most lively children are, if well treated, usually the most obedient. The names of various objects, of common and of uncommon use, are familiar to him; he has seen

a variety of tools, and has been accustomed to handle a few of them. In short, in his education, nothing extraordinary has been said, or taught, or done. Every governess, and every mother who acts as governess to her own children, may easily follow the same course. Where mothers have not time, and where they cannot obtain the assistance of a governess, it were to be wished that early schools could be found for early education. To learn to read is to acquire a key to knowledge: but, alas! it is a key that is not always used to advantage. There is not an hour in the day when something useful may not be taught, before books can be read or understood.

Perhaps parents may pity the father and mother, in Harry and Lucy, as much as they pity the children; and may consider them as the most hard worked and hard working people that ever existed, or that were ever fabled to exist. They may say that these children never had a moment's respite, and that the poor father and mother had never any thing to do, or never did any thing, but attend to these children, answer their questions, and provide for their instruction or amusement. This view of what is expected from parents may alarm many, even of those who have much zeal and ability in education. But we beseech them not to take this false alarm. Even if they were actually to do all that the father and mother of Harry and Lucy are here represented to have done, they would not, in practice, feel it so very laborious, or find that it takes up so preposterous a portion of their lives as they might apprehend. In fact, however, there is no necessity for parents doing all this in any given time, though there was a necessity for the authors' bringing into a small compass, in a reasonable number of pages, a certain portion of knowledge.

Be it therefore hereby declared, and be it now and henceforward understood, by all those whom it may concern, that fathers or mothers (*as the case may be*) are not expected to devote the whole of their days, or even two hours out of the four-and-twenty, to the tuition or instruction of their children. That no father is expected, like Harry's father, to devote an hour before breakfast to the trying of experiments for his children. That no mother is required to suspend her toilet—no father to delay shaving—while their children blow bubbles or

inquire into the construction of bellows, windmill, barometer, or pump. And be it further understood, that no mother is required, like Lucy's mother, to read or find every evening entertaining books, or passages from books, for her children.

Provided always, that said fathers and mothers do, at any and all convenient times, introduce or suggest, or cause to be introduced or suggested to their pupils, the simple elementary notions of science contained in the following pages; and provided always, that they do at all times associate, or cause to be associated, pleasure in the minds of their children with the acquisition of knowledge.

RICHARD LOVELL EDGEWORTH
AND
MARIA EDGEWORTH.

December 8, 1813.

HARRY AND LUCY.

It was Lucy's business to waken her father every morning. She watched the clock, and when it was the right time, she used to go softly into her father's room, and to open the curtain of his bed, and to call to him—

"Papa! papa! It is time for you to get up."

Then she drew back the window-curtains, and opened the shutters—and she put every thing ready for him to dress. She liked to do this for her father, and he liked that she should do it for him; because the attending upon him taught her to be neat and orderly. She and her brother Harry both liked to be in the room with her father when he was dressing, because then he had leisure to talk to them. Every morning he used to tell or teach them something that they did not know before.

One morning, at the beginning of winter, when the weather was cold, Lucy said—

"It is much colder in this room to-day, papa, than it was when you got up yesterday."

"O no! I think it is not nearly so cold to-day as it was yesterday when my father was dressing," said Harry. "What do you think, papa?"

Their father went and looked at *something* that hung in his window, and then answered—

"I think that it is neither hotter nor colder in this room to-day than it was yesterday at the time when I was dressing."

"Are you sure, papa?" said Lucy.

"Quite sure, my dear."

"How can you be quite sure, papa?" said Lucy. "How do you know?"

"I can tell how papa knows," cried Harry—"He looked at the thermometer."

"But how does he know by looking at the thermometer?" said Lucy.

"Come here, and I will show you, for I know," cried Harry. "Stand up on this chair beside me, and I will show you; my uncle told me all about it last summer, when I was looking at the thermometer at his house."

"Look, do you see this glass tube?"

"Yes; I have seen that very often."

"I know *that;* but do you see this part of the tube, at the top, seems to be empty; and this part of it here, at the bottom, and halfway up the glass tube, is full of something white. Do you know what that is?"

"Yes, I remember very well; my uncle told me that is quicksilver; but what then?"

"Stay, be patient, or I cannot explain it to you. Do you see these little marks, these divisions marked upon the edge here, upon the ivory, by the side of the glass tube?"

"Yes; well?"

"And do you see these words printed?"

"Yes; *freezing*, *temperate*, *blood heat*, *boiling water heat* —I have read those words very often, but I don't know what they mean."

"When it is neither very hot nor very cold, people say it is *temperate;* and then the quicksilver would be just opposite to that division where temperate is written. When it freezes, the quicksilver would be down here, at the *freezing point;* and if this thermometer were put into boiling water, the quicksilver would rise up, and it would be just at the place where *boiling water* is written. *Blood heat*, I believe, means the heat that people's blood is of generally—I am not sure about that. But look, here are the numbers of the degrees of heat or cold. Boiling water heat is 212 degrees; and when it is freezing it is 32 degrees."

"And the heat of this room now is—Look, what is it, Lucy?"

Lucy said it was above the long line marked 40.

"Count how many of the little divisions it is above 40," said Harry.

She counted, and said seven; and her father told her to add that number to 40, which made 47.

Then Lucy asked how her father had known that it was as cold in his room to-day as it was yesterday morning, and no colder.

"Because, yesterday morning, the quicksilver rose just to the same place, to 47 degrees, as it does to-day. It always rises or falls, with the same degree of heat or cold, to the same place—to the same degree."

"But look, look, it is moving! The quicksilver is rising higher and higher in the glass!" cried Lucy. "Look! now it is at fifty—fifty-two—fifty-five."

"Yes; do you know the reason of that?" said Harry.

"No; I do not know," said Lucy; "for it is not in the least warmer now in this room, I think, than it was when we first looked at the thermometer."

"That is true; but you have done something, Lucy, to the thermometer, that has made the quicksilver rise."

"I!—What have I done?—I have not even touched it!"

"But you have put your face close to it, and your warm breath has warmed the glass. Now look, when I put my hand, which I have just warmed at the fire, upon the bottom of the thermometer—upon this little round ball or bulb where the greater part of the quicksilver is—look, how it rises in the tube! and now I will carry the thermometer near the fire, and you will see how much more the quicksilver will rise."

Lucy looked at it, and she saw that the quicksilver rose in the thermometer when it was brought near to the fire.

As Harry was putting it still closer to the fire, his father called to him, and begged that he would take care not to break the thermometer.

"O yes, papa, I will take care. If you will give me leave now, I will put it into this kettle of water which is on the fire, and see whether the water is boiling or not. If it is boiling, the quicksilver will rise to *boiling water heat*, will it not?—I will hold the thermometer by the string at the top, so I shall not burn my fingers."

His father stood by while Harry tried this experiment; and Lucy saw that when the water boiled, the quicksilver rose to *boiling water heat;* that is, to 212 degrees.

Then Harry carried the thermometer back again to the window, and left it to cool for some minutes; and they saw that the quicksilver fell to the place where it had been when they first looked at the thermometer this morning; that is to say, to 47 degrees.

"Now you see," said Harry, "the use of the thermometer. It shows exactly how hot or how cold it is."

"It measures the degrees of heat," said their father, "and the name *thermometer* means measurer of heat, from two Greek words; *thermo* means heat, *meter* means measure, as you may observe in the words bar*ometer*, pyr*ometer*, hygr*ometer*, and many others."

"But why, papa, does the quicksilver rise in the tube when it is hot, and fall when it is cold? I do not understand why," said Lucy.

"That is a sensible question," said her father; "and I am not sure that I can answer it so as to make you understand me. It has been found from experience, my dear, that quicksilver *expands*, that is, *spreads out—takes up more room*—when it is heated than when it is cold; and it always expands equally when it is in the same heat. So that, by knowing how much more room it takes up, for instance, when it was held near the fire, than it did when it was hanging in the window, we could know how much greater the heat is near the fire than at the window. Do you understand me, Lucy, my dear?"

"Yes, papa—I think I do. You say that when the quicksilver is heated it—I forgot the word—"

"*Expands*," cried Harry.

"Yes, *expands*. When quicksilver is heated it *expands*, papa."

"But what do you mean by *expands*, my little girl?"

"It spreads out every way—its size increases—it takes up more room."

"Very well—and what then?"

"Why, then—as it expands when it is heated, people can tell, by seeing or measuring the size of the quicksilver, how hot it is."

"True. But how do you think they know exactly how much it increases in size or *bulk* when it is heated to different degrees of heat?—How do they measure and see at once the measure of this?"

"With a pair of compasses, papa," said Lucy.

"Look at this little ball or globe of quicksilver," said her father, pointing to a little ball of quicksilver in the glass, at the bottom of the thermometer. "Would it not be difficult to measure this with a pair of compasses every time you apply heat to it?"

"That would be difficult, to be sure," said Lucy.

"There must be some other way—some way, too, that it can be measured without taking the quicksilver out of the glass every time."

"I know the way!" cried Harry.

"Don't speak—don't tell her—let your sister think and find out for herself. And now I must shave; and do not either of you talk to me till I have done."

While her father was shaving, Lucy looked at the thermometer, and considered about it; and she observed that the thin, tall line or column of quicksilver in the little glass tube, rose from the bulb or globe of quicksilver at the bottom of the thermometer—and, when she put her warm hand upon this bulb, the quicksilver rose in the tube.

"I know it now!" cried Lucy. "But I must not tell it till papa has done shaving, lest I should make him cut himself."

As soon as her papa had done shaving, Lucy, who had stood patiently at his elbow, stretched out her hand, and put the thermometer before his eyes.

"Here, papa! now I will show you."

"Not so near, my dear—do not put it so close to my eyes; for I cannot see it when it is held very near to me," said her father.

"There, papa, you can see it now," said Lucy, "cannot you; and you see the quicksilver in this little glass globe at the bottom of the thermometer?"

"Yes, I see it," said her father.

"When it is heated, and when it expands," continued Lucy, "it must have more room, and it cannot get out at the bottom, or sides, or any way but up this little glass tube. There is an opening, you see, from the uppermost part of that little globe into this glass tube."

"Very well," said her father—"go on, my dear."

"And, when the quicksilver is made hot and hotter, it rises higher and higher in this tube, because it wants more and more room; and the height it rises to shows how hot it is, because that is just the measure of how much the quicksilver has expanded—has grown larger. And by the words that are written here—and by these little lines—these degrees, I believe you call them—you can know and tell people exactly how much the quicksilver rises or falls—and *that* shows *how hot* it is."

"Pretty well explained, Lucy—I think you understand it."

"But one thing she does not know," said Harry, "that, in making a thermometer, the air must be first driven out of the little tube, and the glass must be quite closed at both ends, so as to keep out the air. My uncle told me this—and now, papa," continued Harry, "will you tell me something about the barometer—I know that it is not the same as the thermometer; but I

do not know the difference. Papa, will you explain it to me?"

"Not now. You have had quite enough for this morning, and so have I. I must make haste and finish dressing, and go to breakfast."

"Yes; for mamma is ready, I am sure," cried Lucy. "Here are your boots, papa."

"And here is your coat," said Harry.

"Papa, to-morrow morning, will you let us blow bubbles when you have done shaving?" said Lucy.

"No, no; I want to hear about the barometer to-morrow," said Harry.

"We will settle this when to-morrow comes; and now let us go to breakfast," said their father.

At breakfast, as their father was looking at the newspaper, he found an advertisement, which he read aloud. It said that a man had brought an elephant to a town in the neighbourhood, which he would show to any persons who would pay a shilling a-piece for seeing it; and that the elephant was to be seen every day for a week, between the hours of twelve and three.

Harry and Lucy wished very much to see an elephant; they said that they would rather see it than any other animal, because they had heard and read many curious anecdotes of elephants. Their father said that he would take them this morning to the neighbouring town to see this elephant. Harry immediately went for his "*Sandford and Merton*," and Lucy jumped from her chair, and ran for her "*Instinct displayed*." And they each found in these books anecdotes or stories of elephants, which they were eager to read to their father and mother. Lucy had not quite finished breakfast; so Harry began first; and he read the history of the tailor, who pricked the elephant's trunk with his needle; and he read of the manner in which the elephant punished him. And he read the account of the enraged elephant, which, when his driver's child was thrown in his path, stopped short in the midst of his fury; and, instead of trampling upon the infant, or hurting him, looked at him seemingly with compassion, grew calm, and suffered himself to be led, without opposition, to his stable.

When Harry had finished reading, Lucy said that she

liked these stories of the elephant; but that she had read that part of Sandford and Merton so often that she had it almost by heart.

"But now," said she, "I will read you something that will, I hope, be quite new, even to papa and mamma—unless they have read *my* Mrs. Wakefield's 'Instinct displayed.'"

Then Lucy read an account of Rayoba's favourite elephants, which were almost starved by their keepers before it was discovered how their keepers cheated them of their food. When the prince saw that his elephants grew thin and weak, he appointed persons to see them fed every day; and these people saw the keepers give the elephants the food, of which they were most fond, rich balls, called *massaulla*, composed of spices, sugar, and butter, &c. The elephants took these balls up in their trunks, and put them into their mouths, in the presence of the persons who were to see them fed; but still the elephants, though they seemed to eat so much every day, continued thin and weak.

"At length the cheat was discovered; and it shows the extraordinary influence the keepers had obtained over these docile animals. They had taught them, in the inspector's presence, to receive the balls, and to put them into their mouths with their trunk, but to abstain from eating them; and these tractable creatures actually had that command over themselves, that they received this food, of which they are so remarkably fond, and placed it in their mouths, but never chewed it: and the balls remained untouched, until the *inspectors*" (that is, the people who had been appointed to see them fed) "withdrew. The elephants then took them out carefully with their trunks, and presented them to the keepers; accepting such a share only as they were pleased to allow them."

Lucy rejoiced at finding that this curious anecdote was new to her brother, and even to her father and mother. After they had talked about it for some time, and had admired the docility of these poor elephants, Lucy told what she had read of another elephant, which used to gather mangoes for his master, and to come every morning to his master's tent when he was at breakfast, and wait for a bit of sugarcandy. Lucy's mother then desired her to bring from the library table

the book which she had been reading yesterday evening—"*Mrs. Graham's Account of her Residence in India.*" When Lucy had brought the book, her mother showed her an account of an elephant that had saved the life of an officer who fell under the wheel of a carriage; and a description of the manner in which elephants are tamed: and she told Lucy that she and Harry, if they chose it, might read these passages. They liked particularly to read, at this time, accounts of this animal, that they might know as much as they could of his history before their father should take them to see the elephant. They were happy reading together what their mother had given them leave to read of this book; and then they looked over the prints; and, by the time they had done this, their mother called Lucy to her dressing-room, to write and to cast up sums, and Harry went to his father's study to learn his Latin lesson. Harry and Lucy regularly employed themselves for about an hour every morning after breakfast; and, in general, they attended entirely to what they were doing while they were learning whatever they had to learn—therefore they learned well and quickly. Lucy was learning to write, and she wrote about two lines carefully every day; always trying to mend, each day, faults of which her mother had told her the preceding day. She was also learning arithmetic; and she could, with the help of a dictionary, make out the meaning of half a page of French every day, without being much tired. She knew that nothing can be learned without taking some trouble; but when she succeeded in doing better and better, this made her feel pleased with herself, and paid her for the pains she took. She now read English so well that it was a pleasure to her to read; and to her mother it was a pleasure to hear her. So the reading English was always kept for the last of her morning's employments. She was at this time reading such parts of "*Evenings at Home*" as she could understand. This day she read the "Transmigrations of Indur;" and after she had read this in "Evenings at Home," her mother let her read a little poem on the same subject, which was written by a young gentleman, a relation of hers. Lucy particularly liked the following description of the *metamorphosis*, or *change* of the bee into an elephant:—

"Now the lithe trunk, that sipped the woodland rose,
With strange increase, a huge proboscis grows;
His downy legs, his feather-cinctured thighs,
Swell to the elephant's enormous size.
Before its tusks the bending forests yield;
Beneath his footstep shakes th' astonished field;
With eastern majesty he moves along;
Joins in unwieldy sport the monster throng.
Roaming regardless of the cultured soil,
The wanton herd destroy a nation's toil.
In swarms the peasants crowd, a clam'rous band,
Raise the fierce shout, and snatch the flaming brand;
Loud tramp the scared invaders o'er the plain,
And reach the covert of their woods again."

By the time Lucy had finished reading, and that she had worked a little, and had copied the outline of a foot and of a hand, her mother told her to put by all her books, work, and drawings, and to get ready to go out; for it was now the hour when her father had said that he should take Lucy and her brother to see the elephant.

HARRY and Lucy walked with their father to the neighbouring town, which was about a mile and a half distant from their home; they went by pleasant paths across the fields. It was frosty weather, so the paths were hard; and the children had fine running and jumping, and they made themselves warm all over. When she was very warm, Lucy said—

"Feel my hand, papa; I am sure, if I was to take the thermometer in my hand now, the quicksilver would rise finely—how high, papa?—to how many degrees do you think it would rise?"

"I think," answered her father, "to about seventy degrees of Fahrenheit's thermometer."

"Fahrenheit's thermometer! Why do you call it Fahrenheit's thermometer? I thought it was your thermometer, papa?" said Lucy.

"So it is, my dear; that is, it belongs to me; but it is called Fahrenheit's, because a person of that name first divided the scale of the thermometer in the manner in which you saw that of mine divided. There are other thermometers, divided in a different manner; some of these are called Reaumur's thermometers, because they were first divided so by a person of the name of Reaumur."

"But, papa, will you tell me, said Harry, "something about the barometer!"

His father stopped him. "I cannot tell you any thing about that now, my dear: run on, or we shall not have time to see the elephant; for the keeper of the elephant shows him only till three o'clock each day." Harry and Lucy ran on as fast as they could, and they were quite in time to see the elephant.

They were surprised at the first sight of this animal. Though they had read descriptions, and had seen prints of elephants, yet they had not formed an exact idea of the reality. Lucy said that the elephant appeared much larger; Harry said it was smaller than what he had expected to see. Lucy said that, till she saw it, she had no idea of the colour or of the wrinkled appearance of the elephant's skin. The keeper of this elephant ordered him to pick up a little bit of money which he held upon the palm of his hand. Immediately the obedient animal picked it up with the end of its proboscis, and gave it to his keeper. Lucy said she had never had a clear notion how it moved its trunk or proboscis, nor how it could pick up such small things with it, till she saw it done. Harry said that he had never had an idea of the size or shape of the elephant's feet till he saw them. Lucy said the prints had given her no idea of the size of its ears, or of the breadth of its back. Both she and her brother agreed that it is useful and agreeable to see real things and live animals, as well as to read or hear descriptions of them.

The keeper of this elephant was a little, weak-looking man. Harry and Lucy admired the obedience and gentleness of this powerful animal, that did whatever its master desired, though sometimes it appeared to be inconvenient and painful to it to obey. For instance, when the elephant was ordered to lie down, he bent his fore knees and knelt on them; though it seemed to be difficult and disagreeable to it to put itself into this posture, and to rise again from its knees. Lucy asked what this elephant lived upon, and how much he ate every day. The man said that he fed the elephant with rice and with vegetables, and he showed a bucket which he said held several quarts—this bucketful the elephant ate every day. There was in one corner of the room a heap of raw carrots, of which the keeper said the elephant was fond: he held a carrot to the animal, which took it gently

and ate it. When Lucy saw how gently the elephant took the carrot, she wished to give it one with her own hand; and the man told her that she might. But when Lucy saw the elephant's great trunk turning towards the carrot which she held out to him, she was frightened; she twitched back her hand, and pulled the carrot away from the elephant just as he was going to take it. This disappointment made him very angry; and he showed his displeasure by blowing air through his proboscis with a sort of snorting noise, which frightened Lucy. Harry, who was more courageous, and who was proud to show his courage, took the carrot, marched up to the elephant, and gave it to him. The animal was pacified directly, and gently took the carrot with his proboscis, turned back the proboscis, and put the carrot into his mouth. Harry, turning to his father with a look of some self-satisfaction, said, that "the great Roman general Fabricius was certainly a very brave man, not to have been terrified by the dreadful noise made by King Pyrrhus's elephant, especially as Fabricius had never seen an elephant before." Lucy did not know what Harry *alluded to*, or what he meant; because she had not yet read the Roman history. He said that he would show her the passage in the Roman history as soon as they were at home. And now, having looked at the elephant as long as they wished to look at him, and having asked all the questions they wanted to ask, they went away; they were glad to get out into the fresh air again, for the stable in which the elephant lived had a very disagreeable smell. Lucy pitied this animal for being kept *cooped* up, as she said, in such a small room, instead of being allowed to go about and to enjoy his liberty. Harry then thought of horses that live shut up a great part of their lives in stables. He asked his father whether he thought that horses which have been tamed, or *broke in*, as it is called, and which are kept in stables and taken care of by men, are happier or less happy than wild horses. His father said he thought this must depend upon the manner in which the horses are fed and treated: he observed, that if horses which are tamed by man are constantly well fed, and are protected from the inclemencies of the weather, and are only worked with moderation, it is probable that they are happy; because in these circumstances they are usually in good health, and fat, and their skins look sleek,

smooth, and shining. From these signs we may guess that they are happy; but as they cannot speak and tell us what they feel, we cannot be certain.

During the walk home, Harry and Lucy took notice of many things. There was scarcely an hour in their lives in which they did not observe and learn something. One subject of observation and of conversation led to another; but it is impossible to give an account of *all* these things.

When they got home, Lucy reminded her brother of his promise about Fabricius and the elephant: he showed her the passage in the Roman history which he had read; and that evening Lucy asked her mother if she might read the whole of her brother's Roman history. Her mother gave her a little History of Rome,* with sixty-four prints in it; and she told Lucy, that when she knew all the facts told in this history, it would be time enough to read another, which might tell her more particulars of the Roman history.

The next day being Sunday, Harry and Lucy went with their father and mother to church. The morning lesson for this day was one of the chapters of the Bible which contain the history of Joseph and his brethren. Harry and Lucy listened attentively, and when they came home from church, they told their father that they wished very much to know the end of that history of which they had heard the beginning read by the clergyman at church. Their father took down from his bookcase the large family Bible, and he read the whole of the history of Joseph and his brethren, with which the children were very much interested and touched.

In the evening they each read to their mother one of Mrs. Barbauld's "Hymns in prose for Children." Harry and Lucy loved these hymns, and they showed their mother the passages that they liked particularly in those which they read this day.

"Mamma, this is the passage which I like the best," said Lucy:—

"'Look at the thorns that are white with blossoms,

* Probably Mrs. Trimmer's.

and the flowers that cover the fields, and the plants that are trodden in the green path: the hand of man hath not planted them; the sower hath not scattered the seeds from his hand, nor the gardener digged a place for them with his spade.

"'Some grow on steep rocks, where no man can climb: in shaking bogs, and deep forests, and desert islands: they spring up everywhere, and cover the bosom of the whole earth.

"'Who causeth them to grow everywhere, and * * * * * * * * * * * *

and giveth them colours and smells, and spreadeth out their thin transparent leaves?

"'How doth the rose draw its crimson from the dark brown earth, or the lily its shining white? How can a small seed contain a plant? * * * * *

"'Lo! these are a part of his works, and a little portion of his wonders.

"'There is little need that I should tell you of God, for every thing speaks of him.'"

Harry was silent for a moment after he had heard these passages read again, and then he said—

"I like that very much indeed, Lucy; but now let me read to you, mamma, what I like better still.

"'Negro woman, who sittest pining in captivity, and weepest over thy sick child; though no one seeth thee, God seeth thee; though no one pitieth thee, God pitieth thee: raise thy voice, forlorn and abandoned one: call upon him from amid thy bonds, for assuredly he will hear thee.

"'Monarch, that rulest over a hundred states, whose frown is terrible as death, and whose armies cover the land, boast not thyself as though there were none above thee—God is above thee; his powerful arm is always over thee! and, if thou doest ill, assuredly he will punish thee.'"

The next morning, when Harry and Lucy went into their father's room, Harry drew back the curtain of his father's bed, and said—

"Father, you promised to tell me something about the barometer, and it is time to get up."

His father answered without opening his eyes—

"Do you see two tobacco-pipes?"

Harry and Lucy laughed: for they thought that their father was dreaming of tobacco-pipes, and talking of them in his sleep. Lucy recollected that her mother said he had been writing letters late the night before, and she said to her brother—

"We had better let him sleep a little longer."

"Yes, do, my dear," said her father, in a sleepy voice: "and take the two tobacco-pipes, and my soap, and my basin, and the hot water, Lucy, that you brought for my shaving, and you may blow soap-bubbles in the next room for half an hour; and, at the end of that time, come and waken me again."

Harry looked about the room, and he found on his father's table the two tobacco-pipes which he had been so good as to put there the night before. Taking care to move softly, and not to make any noise that should disturb their father, they carried out of the room with them the hot water, basin, soap, and tobacco-pipes. During the next half hour they were so happy blowing bubbles, watching them swell and mount in the air, and float, and burst, trying which could blow the largest bubbles, or the bubbles which would last the longest, that the half hour was gone before they thought that a quarter of an hour had passed. But Lucy heard the clock strike, and immediately she knew that the half hour was over, and that it was time to go and waken her father again. So she went directly, for she was very punctual. Her father was now awake, and he got up; and while he was getting up she began to talk to him of the pretty soap-bubbles which they had been blowing: but Harry was impatient to ask his father something about the barometer.

"Now, Lucy, let us have done with the soap-bubbles," said Harry; "I want to learn something seriously—papa, I want to understand the barometer perfectly before I go next week to my uncle's, that he may find I am not so ignorant as I was the last time he saw me; and, besides, my cousin Frederick will be at home, and he is only a year or two older than I am; and my uncle says that Frederick understands the use of all the instruments in his room—but I did not understand even the barometer—father, will you explain it to me this morning?"

"Just let me first show papa this one large bubble," said Lucy, "and then you may go to the barometer."

Lucy blew a large bubble from the end of her tobacco-pipe; but it burst before it had risen far. Then Lucy put by the tobacco-pipe and said—

"Now I will not interrupt you any more with my bubbles."

"But, perhaps, my dear Lucy," said her father, "the bubbles may lead us to the knowledge of some things necessary to be known before I can explain a barometer. Do you know what a bubble is?"

"O yes, papa," said she; "I remember you told me a great while ago,—a bubble is—"

She was forced to pause to think, however, before she could describe it.

"I believe it is air blown into a round case or globe of *something*—a soap-bubble is air in a round case of soap and water—but, papa, I have often seen bubbles on the top of water; *they* are only air and water. But how can the case be made of water? I can conceive that a globe of soap and water might stick together, because I know that soap is sticky; but I wonder at water's sticking together so as to make a hollow globe."

"When you look at water," said her father, "or at quicksilver, you perceive that they are very different, not only in colour, but in their other properties."

"*Properties*, papa," said Lucy—"that is a word of which you taught me the meaning—properties are what belong to things."

"One of the properties of water is *fluidity*," said her father—"sand, on the contrary, is not fluid. Sand may be poured out like water or quicksilver; but the grains of which it is composed are separate, and have no visible attraction for each other. The parts of water *cohere* or stick together but slightly; a small force divides them; but still they have an obvious tenacity."

"Papa! what is *obvious tenacity*?—Tenacity, I know, is stickiness—but what does *obvious* mean?"

"Easily seen—plain—easy to be perceived—by obvious tenacity I mean tenacity which you can easily perceive; though nothing viscid or sticky is added to the water, you see that water can be spread by air so as to form the outer case of a bubble."

"But when soap is added to water," said Lucy, "larger bubbles can be made."

"Yes—why?"

"Because the soap makes the parts of the water stick together more strongly—but, papa," continued Lucy, "what is the reason that a bubble bursts? for if the outside case is strong enough to hold it at first, why should not *that* hold it as well always? yet at last it bursts—what is the reason of this?"

Her father said that he believed there were several causes which might make a bubble burst; and that he was not sure either that he knew all of them, or that he could explain them all so as to make Lucy understand them. He mentioned some of the causes; for instance, the wind blowing against the bubble might break it; or the heat might expand the air withinside of it, and burst it; or, at other times, some of the water of which the outer skin of the bubble is made may run down from the top to the bottom, till it makes the bottom so heavy, and the top so thin, that it bursts.

Here Harry was heard to utter a deep sigh. His father smiled, and said—

"Poor Harry thinks we shall never get to the barometer; but have patience, my boy, we have not gone so far out of the way as you think we have. Now, Harry, run to my workshop, and bring me a bladder which you will find hanging up near the door. And, Lucy, run for the little pair of bellows which is in your mother's dressing-room."

Harry brought the bladder, and Lucy brought the bellows. They were curious to see what their father was going to show them; but just then the breakfast-bell rang. Their father could not show or tell them any thing more that morning, for he was forced to finish dressing himself as fast as he could, and the children helped him eagerly. One reason why they liked to come to their father every morning, and to be taught by him, was, that he never tired them by forcing them to attend for a long time together.

Ten minutes at a time he thought quite sufficient at their age; but then he required complete attention. Whenever he found that they were not thinking of what he was teaching them, he would not say any more to them—he sent them away. For this they were always sorry; and this *punishment*, or rather this *privation*, was sufficient to make them attend better next day. It very seldom happened that they were sent out of their fa-

ther's room. Though he never taught them *in play*, as it is called, yet he made what they learned as interesting to them as he could; and he made work and play come one after the other, so as to refresh them. He and their mother took care that Harry and Lucy should neither be made to dislike knowledge, by having tiresome, long tasks, nor rendered idle, and unable to command their attention, by having too much amusement. Spoiled children are never happy. Between breakfast and dinner, they ask a hundred times "What o'clock is it?" and wish for the time when dinner will be ready, or when pudding or apple-pie will come. And when dinner is over they long for tea-time, and so on. Or they *must* have somebody to amuse them, or some new toys. From morning till night they never know what to do with themselves: but the whole long day they are lounging about, and troublesome to everybody, continually wishing, or asking, or crying for something that they have not. Poor miserable creatures!—Children who are not spoiled will smile when they read this; and will be glad that they are not like these, but that they are like Harry and Lucy. Harry and Lucy loved pudding and apple-pie as well as most people do; but eating was not their only or their greatest pleasure. Having acquired a love for reading, and for knowledge of many sorts, they found continually a number of employments and of objects which entertained and interested them. So that they were never in want of new toys or of somebody to amuse them. If any extraordinary amusement was given to them, such, for instance, as their seeing an elephant, they enjoyed it as much as possible; but, in general, Harry and Lucy felt that they wanted nothing beyond their common, every-day occupations. Besides their own occupations and amusements, there was always something going on in the house which entertained them; they were now able to understand their father and mother's conversation: living constantly with them (*and not with servants*), they *sympathized*, that is, *felt along with* their parents, and made, to a certain degree, a part of their society. Frequently their mother read aloud in the evenings. Harry and Lucy were never *desired* to listen; but sometimes they could understand what was read, and sometimes they found it entertaining.

It happened one winter evening that their mother

began to read a French book, which they could not understand, yet it seemed to amuse their father so much that they wished to know what it was about. All that they heard their father and mother say to one another about it, made them sure that it must be entertaining; they left their map of Europe, which they had been putting together, and Lucy went and looked over her mother's shoulder at the book, and Harry leaned on his elbows opposite to his mother, listening eagerly to try if he could make out any meaning; but he could understand only a word or a short sentence now and then.

Their mother observed their eagerness to know what she was reading, and she was so good as to translate for them, and to read to them in English the passages which she thought most entertaining. She told them, first, what it was about.

It was the account given by a traveller of a high mountain in Switzerland, and of the manner of living of the people by whom it is inhabited. Harry and Lucy turned to the map of Europe which they had been putting together, and pointed to Switzerland as their mother spoke. The name of the mountain of which she was reading an account was mount *Pilate*. The name was taken, as their father told them, from the Latin word *Pileus*, a hat, the top of this mountain being almost always covered with what looks like a hat, or cap of clouds. Different points or heights of this mountain are called by different names. The most curious, difficult, and dangerous part of the ascent lies between the point called the *Ass* and another part called *the Shaking Stone*.

"O mother! read about the shaking stone," cried Harry.

"No, Harry, let mamma begin here, where there is something about *de très belles fraises*. I know the English of that, *very fine strawberries*."

Her mother began to read just where Lucy's finger pointed.

"'At the bottom of this road up to the shaking stone is a bank which is covered with very fine strawberries from the middle of the summer till the 21st of December, if the snow does not cover them before that time. And they may be found even under the snow if people will take the trouble to look for them.

"'All the fir-trees near this spot are called *storm-*

shelterers; because they seem to have been placed there on purpose to shelter people from the storms. Some of them afford a shelter of fifty feet in circumference. The rain cannot penetrate through the thick branches of these trees. The cattle are often seen gathered together under them, even in the finest weather; but it generally happens that a storm comes on within a quarter of an hour after the cattle have taken shelter in this manner.' "

"How do the cows or horses foresee the storm, mamma?" said Lucy.

"I do not know, my dear."

"Let my mother go on reading, and ask all your questions afterward, Lucy," said Harry.

"If I can but remember them," said Lucy.

" 'From the foot of the mountain to the point where there is the village called Brundlen, the road is tolerably safe. The people can even drive their cows up here; but with this precaution: two men go with the cow, one at the head and the other at the tail, and they hold in their hands a long pole, which they keep always between the cow and the precipice, so as to make a sort of baluster, or rail, to prevent her from falling.

" 'People are forced to walk very slowly on this road. Half way up, you come to a curious fir-tree. From its trunk, which is eight feet in circumference, spread nine branches, each about three feet in circumference, and six feet long. From the end of each of these branches, which are about fifteen feet from the ground, there rises, perpendicularly, a fir-tree. This tree looks, in shape, something like a great chandelier, with all its candles

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The village of Brundlen is the highest and last village on the mountain. It stands at the foot of a rock, from which enormous stones and fragments of rock frequently roll down; but the houses are so situate, *under the projecting part of the rock*, that all which falls from it bounds over without touching them. The inhabitants of this village possess about forty cows. The peasants mow only those parts of the mountain where the cattle cannot venture to go to feed. The mowers are let down or drawn up to these places by ropes from the top of the rock; they put the grass, when they have mowed it, into nets, which are drawn up or let down by the same ropes whenever it is wanted. It is remarkable,

that the kinds of grass and herbs which are found in these mountainous places are quite different from those which grow in the low countries.' "—

"My dear children, is it possible that you are interested about these grasses?" said their mother.

"No, mamma," said Lucy, "not much about the grasses; but I like that part about the mowers, let down by ropes; and I like to hear it, just as you read it to papa."

"'Round some of these stones, which have partly fallen or mouldered away, grows a flower which is a very dangerous poison. At four or five feet distance from this plant the cattle perceive its smell, and they leave the grass round it untouched. The flowers of the different kinds of this plant are of a fine deep blue, yellow, or white. The white are the most uncommon; and the poison of these, it is said, is the most dangerous. Some years ago a young man gathered some of these flowers, and held them in his hand while he descended the mountain to go to a dance. When he was near the place where he was to dance, he felt that his hand was numb, and he threw away the flowers. He danced afterward for an hour or two with a young woman, holding her hand all the time; he grew warm; and the poison from the poisonous flowers, it is supposed, was communicated from his hand to hers; for they both died that night.'"

Harry and Lucy were shocked at this story.

"But, mother," said Harry, "do you think it is true?"

"That was the very thing I was considering," said his mother.

Then his father and mother began to talk about the probability of its being true or false.

They looked back for the description of the flower, and for the Latin name, which their mother, knowing that the children would not understand, had passed over. By comparing the name and description of this flower with those in botanical books, where the description and accounts of the properties of plants are given, they found that the plant of which they had been reading was a species of *aconite*, called in English *wolf's-bane*, or *monk's-hood*; and, as several instances were mentioned of its poisonous and fatal effects, they were inclined to believe that the story of the young man and woman's death might be true.

Lucy, seeing in some of the botanical books in which her mother had been looking pretty coloured drawings, or prints of flowers, asked whether she might look at them. Her mother said that she might at some other time, but not this evening; because Lucy could not attend both to looking at these prints and to what she heard read aloud. So Lucy shut the books, and she and Harry put them into their places again in the bookcase, resolving that they would look at them together *the next day.*

"Now, mamma," said Harry, as they drew their seats close to her, and settled themselves again to listen; "now for the shaking stone, mamma."

Their kind mother began immediately, and read on as follows:—

"'This stone is at the summit of the mountain (called the Ober Alp); it overhangs the rock a little, and appears as if it would fall; but this is really impossible, unless it were thrown down by a violent earthquake. The stone is as large as a moderate-sized house. When any one has the boldness to get upon it to lie down, and let their head overhang the stone, they will feel the stone shake, so that it seems as if it were going to fall that moment. In 1744 the stone ceased to shake. About six years afterward, somebody discovered that this arose from a little pebble, which had fallen through a crack, and had remained under the stone. A man fastened a great hammer to a pole, and after frequently striking the pebble with the hammer, he succeeded in dislodging it. Immediately the stone began to shake again, and has continued ever since to vibrate.'"

"How glad the man who struck the pebble from under the stone must have been, when he saw it begin to shake again!" said Harry. "I should like to have been that man."

"Now I," said Lucy, "could not have managed the great pole and hammer: and I would rather have been the person who first discovered that the pebble had got under the stone, and that it was the cause which prevented the stone from shaking."

"O, but anybody who had eyes could have seen that," said Harry.

"And yet all those people who lived in that country had eyes, I suppose," said Lucy; "but they were six years before they saw it."

"They had *eyes and no eyes*," said her mother, smiling.

"That is true: I understand what you mean, mamma," said Lucy. "I have read 'Eyes and No Eyes,' in 'Evenings at Home;' and I like it very much. But will you go on, mamma, if there is any thing more that is entertaining?"

"There is something more that perhaps would entertain you," said her mother; "but I will not read any more to you to-night, because it is time for you to go to bed."

"To-morrow night, mamma, will you read some more to us?"

"I will not promise, my dear—perhaps I may have something else to do—or perhaps you may not deserve it so well to-morrow. When to-morrow night comes, it will be time enough to give you an answer."

The next morning, when Harry and Lucy went into their father's room, they took care to have the bladder and the bellows ready by the time that he was up, as he had promised to show them some experiments.

"Now," said he, "we will fill this bladder with air, by blowing air into it with the bellows."

He put the end of the bellows into the neck of the bladder, and bid Harry hold the bladder, and Lucy blow the bellows.

"It is now quite full, papa," said Lucy: "I will tie the air in with a waxed string round the neck of the bladder —I know how to do that. Look, how full, and round, and tight it is."

"So it is," said her father; "but now I want to let out some of the air that is in this bladder, without letting out all of it: how shall I do that?"

"I do not know," said Lucy; "for if I untie this string, I am afraid all the air that is in the bladder now would come out."

"That it certainly would," said her father.

"How shall we manage it?" repeated Harry and Lucy: after considering for some time, Harry observed that, beyond the place where the bladder was tied, there was enough of the neck of the bladder left to admit the nose of the bellows: he proposed that they should put in the end of the bellows, and tie the bladder round it,

and then untie that string with which they had at first tied the neck of the bladder. His father said that this would do, but that he would show him what would do better. He gave him a little pipe of wood, about two inches long, that had a wooden stopper at one end, that could be easily put into the pipe, and easily taken out. He told Harry that this kind of pipe and stopper are called a *spigot* and *faucet:* he fastened the faucet into the neck of the bladder, so that he could stop the air from coming out of the bladder when it was full, and he could at any time let out the air, by taking away the peg or spigot. Then he let out a great part of the air that was in the bladder, till it was nearly empty, stopped the faucet again with the spigot, and then carried the bladder to the fire.

"Now you will see," said their father, "that the heat of the fire will swell the small quantity of air remaining in the bladder, till it will fill as great a space as that which was filled by all the air which we forced into it at first by the bellows. Here, Harry, take this to the fire while I shave myself."

The children held the bladder near the fire, but it did not swell out immediately; and after they had held it a few minutes, they began to think that it would *never do*, as Harry said. His father told him that he must not be so impatient if he intended to try experiments.

"If you are tired of holding the bladder," said he, "put it down on the hearth, leave it there, and go and do or think of something else; and, in about a quarter of an hour, perhaps, it will begin to swell out."

"A quarter of an hour! that is a great while, indeed!" said Harry.

However, the quarter of an hour passed while the children were putting some little drawers of their father's in order. When they returned to look at the bladder, they saw that it was beginning to swell, and they watched it while it gradually swelled. First one fold of the bag opened, then another, till at last it was again swelled out into the shape of a globe.

"This is very extraordinary!" said Lucy, "that the little—the very little air which papa left in the bladder should have swelled out to this size, without any thing being added to it."

"Without *any thing* being added to it?" repeated her father: "think again, my dear."

"I have *thought again*, papa; but I assure you nothing was added to the air: for we never opened the bladder after you put in the—what do you call it?—which fastens it."

"The spigot," said Harry.

"The spigot," said Lucy. "Well, papa, I say nothing was added to the air."

"I say, daughter, you are mistaken."

"Why, papa, we did nothing in the world but hold the bladder to the fire, and leave it before the fire, and nobody touched it, or put any thing to it, or near it."

Still her father said—

"Think again, Lucy."

She recollected herself, and exclaimed—

"I know what you mean now, papa—heat—*heat* was added to it!"

"Yes," said her father; "heat mixed with the air in the bladder; and, by separating *the parts* of the air from each other, made them take up more room. Now take the bladder into a cold place; hang it up here near the window, and let us see what will happen."

"I know what will happen, papa," said Lucy. "When the air in the bladder grows cold, it will *take up less room.*"

"It will contract," interrupted Harry.

"And then," continued Lucy, "the bladder will shrink, and become less and less, and it will fall in folds in a kind of loose bag, just as it was before we carried it to the fire. I shall like to see whether this will happen just as I think it will."

Lucy hung up the bladder in a cold place, and watched it for a few minutes; but she did not perceive any immediate alteration.

"It will be as long in shrinking as it was in swelling out," said she, "and breakfast will be ready, I am afraid, before it shrinks."

"I know a way of making it shrink quickly," cried Harry.

"What is it?"

"I will not tell you, but I will show you," said Harry. "You shall see what—you shall see."

He ran out of the room, and soon returned with his little watering-pot full of cold water.

"Now, Lucy," said he, "hold the basin for me under the bladder, that we may not wet the floor—hold it steady."

He poured cold water from the nose of the watering-pot so as to sprinkle the water all over the bladder, and immediately the bladder began to *collapse*, or shrink; and soon, to Lucy's delight, it was diminished to the size which it had been before it was carried to the fire, and it hung like a loose or *flaccid* bag.

"Papa, look!" said she, "look how much less room the bladder takes up now!"

"Then," said her father, "something must have been taken away from what was withinside of it."

"Yes," said Lucy.

"What was taken away?"

"Heat," replied Lucy.

"What took away the heat?"

"Cold water."

"How did that happen!"

Lucy answered, she believed the heat went into the water—that the water must have taken away the heat of the air that was within the bladder.

"*Attracted!*" cried Harry; "you should say that the water *attracted* the heat from the air."

"Well! *attracted*," said Lucy;—"first, I suppose the bladder itself became warm, by touching the warm air withinside of it; then the water took, or—*attracted*, as you tell me I must say—some of the heat from the bladder; then the bladder attracted some more heat from the inside air; and so on."

"Accurately stated, Lucy," said her father; "now you have thought enough of all these things—stay!—before you go, tell me what you have learned from the experiments you have tried this morning."

"*Experiments*, papa!" said Lucy, smiling, and looking surprised—"I did not think that we had been trying experiments!—I thought that only grown-up people and philosophers could try experiments."

"There you are mistaken, my dear," said her father; "an experiment is only a trial of any thing, or something done, to find out what will be the consequence. You carried the bladder to the fire, or poured cold water upon it, to find out what would happen to the air withinside of it. Children can try some experiments as well as grown-up people can."

"Papa," cried Harry, "I have heard you talk of Dr. Franklin—"

"And of Newton," said Lucy. "I heard something—"

"Very likely, my dear," interrupted her father; "but do not fly off to Dr. Franklin and Newton till you have answered the question I asked you just now. What have you learned from the experiments you tried this morning?"

After Lucy had recollected what she had seen and heard, she answered;—"I have learned that heat expanded or spread out the air in this bladder, and that *cold*—"

"That is, the want of heat," interrupted her father.

"That cold, or the want of heat, made or let the air in the bladder *grow smaller*."

"*Contract*," said Harry.

"The same effects would be produced by taking away heat, not only from the air in that bladder, but from all air," said their father. "Now put the bladder in the place where you found it, and let us divert ourselves with something else. Can you cut capers, Harry?"

"Yes, papa; but first I want to say something:—How very little we learn every morning! I looked at your watch when I came into your room, and it was just half after eight o'clock, and now it is nine. So we have been here half an hour—half an hour!—I can scarcely believe that we have been here so long, papa?"

"Then you have not been tired, Harry?"

"No, not at all; but I am afraid papa, that if we learn so very little every day, we shall never get on."

"You need not be afraid of that, my dear; learning a little, a very little, accurately, every day, is better than learning a great deal inaccurately."

"A little and a little every day regularly, makes a great deal in many days," said Lucy; "I have found this to be true when I have been at work, and when I have done but very little each day."

"But when shall we get to the barometer?" said Harry.

"Oh! is that what you mean?" said his father—"patience, my boy!—patience till to-morrow!"

"Patience till to-morrow I must have, for I cannot help it," said Harry, sighing—"I wish to-day was over."

"No," said Lucy, "you need not wish to-day was over. Recollect, brother, that we have a great many pleasant things to do to-day. I am sure, Harry, you cannot wish

that this evening was over, because you know—though mamma did not promise it—if we deserve it—as I am sure we shall—she will read to us some more of that entertaining man's travels."

During this day, Harry and Lucy were attentive to every thing that they had to do. It snowed, so that after they had finished their lessons they could not go out, or take as much exercise as usual; but they warmed themselves by playing at hide and seek, and at battledoor and shuttlecock, and at ball, at which they were allowed to play in an empty gallery, where they could do no mischief.

The evening came, and they were eager to know whether their mother would read to them this night. She smiled when Lucy brought the book to her, and said—

"Yes, my dears, you have both been attentive to every thing you had to do to-day, and I shall be glad to give you this pleasure; but first I must write a letter."

"While you are writing, mamma," said Lucy, "may we try if we can make out any of this French? here is something that you missed about *la statue et la caverne* —the statue and the cavern—which looks as if it was entertaining; and I wish I could make it out—may I try, mamma?"

"Yes, my dear, provided you do not turn me into a dictionary; because I cannot write my letter and be your dictionary at the same time."

Without their mother's assistance, Harry and Lucy made out, pretty well, the sense of what they wanted to read; and, as soon as their mother had finished her letter, Lucy began to tell her all that they had translated.

"We have found out, mamma, that it is an account of a man of the name of Huber, who wanted to go into a cavern, in a rock of black or blackish stone (*noirâtre*), to see a statue called *Dominique*, which was of white stone, and seemed to be about thirty feet high,—above twice as high as this room, mamma! But no one had ever been able to get to this statue, the way to it was so dangerous; they could, however, distinguish plainly that it was the figure of a man—doing something on a table—

"'*Accoudé sur* une table.'—

"Mamma, you must, if you please, be so good as to tell us what *accoudé* is; for we could not find it in the dictionary."

"It is just what Harry is doing at this moment—leaning his elbows on the table."

"Oh, now I understand it perfectly. The figure of a man, leaning with his elbows on the table, his legs crossed, and seeming to guard the entrance of this cavern. Well, ma'am, nobody had ever been able to get to this statue—I told you that."

"True, my dear; therefore you need not tell it to me again."

"Very well, ma'am—but this man, of the name of Huber, who was a very courageous person, was determined to get to the statue. So, finding that he could not clamber up from the bottom of this rock, he had himself let down from the top, by a long, a very long rope, which he tied, I suppose, round his body; but it does not say so. When he was let down—what do you think he found? He found—how provoking!—that the rock overhung the cavern so much, that, as he hung down this way, *like a plumb line*, as Harry says, he never could reach the entrance of the cavern, which was far in, far under the rocks; so he was forced to call to the people to draw him up again. But he had seen enough to be almost sure that the statue was really a statue of a man, and not a white stone, that looked like a man, as some people thought it was—*So*—then there is something about the statue's not being '*l'ouvrage fortuit de la nature*'—*that* we could not understand, so we missed it. *So* the man, Huber, got a pole, to the end of which he fastened a hook, which he thought he could hook into the rock and pull himself closer and closer to the entrance of the cavern, and so get in—so—"

"But, my dear, leave out *so*—do not *sew* your story together *so*."

"*So*, ma'am—I mean—he was let down a second time—but, oh! now, ma'am, the terrible thing!—the rope twisted and twisted continually; his weight was more than the rope could bear, and it broke, and he fell, and was dashed to pieces!"

"Poor man! Was not he very courageous, papa?" said Harry—"I admire him very much."

"He was courageous, certainly," said Harry's father; "but, before we admire him very much, we should con-

sider what his motive was, or what good he could do by hazarding his life. If it was with the hope of being of any great service to himself or to any one else; if it was to accomplish any useful or generous purpose, I should admire a man for risking his life: but I cannot admire him for running the chance of breaking his neck merely to see a statue, or to find out whether it was the statue of a man or a white stone. I remember that, when I was at Clifton some years ago, a boy was dashed to pieces by falling from a high rock, to which he had climbed to look for a bird's nest. A few days after this accident happened, I saw another boy climb to the same place in search of the same nest—this was folly, not courage."

"It was, indeed," said Harry—"but, mamma, will you be so kind as to read on?"

"Next comes," said their mother, "an account of the traveller's finding, in the wildest part of the mountain, a hut, inhabited by ten or twelve children, who lived there with a dog which looked more savage than themselves—they took care of a flock of goats, and lived chiefly on the milk of the goats. As soon as a stranger appeared on this part of the mountain, the children ran away, and shut themselves up in their hut, and sent their dog after him—a dog he might be called, because he barked, but he was a peculiar and hideous-looking creature—"

"Is this all, mamma," said Lucy, as her mother stopped, "all that the man tells about the children?—I wish he had told more—I want to know how these children lived together, and whether they quarrelled, like those* in '*The Children's Friend*,' who asked their father to let them live by themselves, and govern themselves for one day—only for one day!—and what difficulties they got into!"

"Yes," said Harry; "but those children made themselves sick by eating and drinking too much, and they quarrelled, because they had nothing to do but to play all day long; but there was no danger that these poor children on the mountain should eat too much, for they had scarcely any thing but goat's milk, and they must have had enough to do, as there was no one to do any thing for them—but, papa," continued Harry, after

* Les enfans qui veulent se gouverner.

thinking for a minute, "I want to know who was king among them, and I want to know what laws they made for themselves, and what punishments they had; for they could not have gone on long without some laws, I am sure."

"Pray, what would have been your laws, Harry?" said his father—"I give you a week to consider of it—you and Lucy may consult together—now let us go on with '*The Traveller's Wonders.*'"

"I do not find any thing else worth reading to you, my dears," said their mother, "except an account of the manner in which these mountaineers are taught to walk in dangerous places; and an account of the honesty of the people, in preserving for the hunters the game which belongs to them."

"Ha! I shall like to hear that; we must remember *honesty* the first thing in our laws," said Harry.

"There are six hunters, who divide among themselves and among the inhabitants of the mountain all the game which they kill; and, in return, they are fed for nothing in the cottages. They undergo great labour, and go into dangerous places in pursuit of the goats and cocks of the wood. When these animals are shot, they often roll down from the highest rocks to the valleys beneath; and the peasants, who live in these valleys, when they find these dead birds and beasts, take care of them, and faithfully return them to the hunters. If this was not done, the hunters would be obliged to walk many miles to pick up the game which they kill. You see that this honesty is useful to *all* the people who practise it—so is honesty in all cases; therefore, Harry, I think you will do right to remember it first in your laws."

"So I will," said Harry. "But now, mamma, will you go on to the part which tells how the people learn to walk in dangerous places?"

"I am afraid it is too late to read any more to-night," answered his mother, looking at her watch. "Good-night, my dear children—we must put off the account of the walking till another time."

"Now for the barometer!" said Harry, as he went into his father's room in the morning.

"Not yet, my dear boy," said his father; "you must know something more before you can understand the barometer."

Harry looked disappointed for a moment; but recovering himself, he turned to observe what his father was doing. He was filling the bladder with water, to measure how much it would hold: it held five quarts, that is, ten pints.

"If you fill it ever so often, you cannot force more water into that bladder, can you?" said his father.

"No, certainly not; for, if we try to put in any more water, it will run over," said Lucy.

"Then you find," said her father, "that we cannot force the parts of water nearer to each other, as you did those of air—water differs from air in this respect."

"Yes," said Lucy, "for when you poured water upon the bladder, the air withinside took up less room than before; therefore, the parts of the air must have come nearer together."

"But, perhaps, father," said Harry, "if this bladder was strong enough to bear our pressing water into it, we could force more in: if you were to take an iron vessel, and try to force water into it, would it not be possible to squeeze the parts of the water closer together, by pressing down the top of the vessel?"

"No, my dear," continued his father; "if a vessel had a top, made to screw into its mouth, to fit it exactly; and if water was poured into the vessel till it came to the very mouth of it, you could not squeeze the water down by screwing the top on. If you force the cover to screw on, the water will make its way through the screw till the cover is screwed quite down, or it will burst the vessel."

"Burst the vessel!" cried Lucy—"an *iron* vessel, papa!—Is that possible!—I should like to see that experiment—but I believe it would be dangerous, because, when the iron vessel bursts, the bits of it might be thrown against us, and hurt us—papa, I remember your giving mamma an account of some vessel that burst from having too much hot water—too much steam, I mean, in it."

"Yes, because heat was added to the water," said Harry—"water in the teakettle *boils over* when it is made very hot; and I suppose that if the top of the teakettle was screwed down so tight that no steam

could get out, and if the spout was stopped in such a manner that the steam could not come out there, the teakettle would burst."

"Yes," answered his father.

"Then there is a way of swelling water by heat?" said Lucy.

"It is not the water which swells," said her father; "while it continues water, it does not swell; but when heat mixes with it, or when it becomes what we call steam, or vapour, then it swells, and takes up a great deal more room than it did before."

"But there was something I was in a great hurry to say," cried Lucy, "and now I have forgotten it—talking of the *boiling over of the teakettle* put it out of my head."

"You mean the boiling over of the water in the teakettle," said her father.

"Yes, papa: but what was I thinking of?" said Lucy.

"Recollect," said her father, "what you were thinking of just before we spoke of the teakettle, and then, perhaps, you may recollect what you want to remember."

"We were talking of the swelling or not swelling of water by heat—O, I recollect what it was!" said Lucy—"I know a way, papa, of swelling or expanding water without heat."

"What is that way?" said Harry.

"There is a way, I assure you, brother; and you know it, or, at least, you have seen it, as well as I—don't you know that when water is frozen it swells?"

"How do you know that, sister?"

"I know that bottles, filled with water, often burst when it freezes," said Lucy; "I assure you I have seen the water-bottle in my room broken by the frost."

"That bottle had a very narrow neck," said Harry: "bottles or jugs that are as wide at the mouth, or wider, than elsewhere, do not burst when the water withinside of them is frozen—the jug in my room never bursts, though the water is often frozen in it."

"What is the reason of that, do you think?" said her father.

"Because there is room for the ice to expand," said Lucy.

"But does the ice expand, papa?" said Harry.

His father answered—"At the moment of freezing,

the parts of ice are found to be farther from one another than the parts of the water were."

"Does cold get between the parts of the water?" said Lucy.

"No, no," said Harry—"cold is not a *thing*; papa told us that it is only a word that expresses want of heat."

"Call it what you will," said Lucy, "but still I do not understand—what is it, papa, that gets between the parts of the ice, and makes it take up more room, and at the moment it freezes?"

"I do not know, my dear," answered her father.

"You don't know, papa!—I thought you knew every thing."

"No, my dear," said her father—"there are a great many things of which I know as little as you do—it is difficult to know any thing well. Upon this very subject, of which you were speaking, there are different opinions; and I do not like to tell you any thing of which I am not sure."

"But, papa," continued Lucy, "one thing you can tell me, or I can tell you, that ice is the same thing as water, and water is the same thing as ice, is not it so? except that one is fluid and the other solid."

"Not quite the same—water is ice, with heat added to it, and a little air."

"Then I should have thought," said Lucy, "that water ought to take up more room than ice."

"Why, my dear?"

"Because water is ice, and something more—something added to it. We saw, when we heated the bladder, the hot air took up more room than cold air, because it was air and something added to it; for the same reason, I should have thought, that if you add heat to ice, and so turn it into water again, that the water should take up more room than the ice; because, *I say*," cried Lucy, struggling to explain herself, "the water is ice, and something more—heat is added to it, you know."

"I understand you, my dear," said her father, "and what you say is very reasonable. I should have thought as you do if I had not seen the experiment tried; but we find from experience that this is not the case. However, try the experiment for yourself."

"So I will, papa," cried Lucy. "So we will, and

this very night, too, if it freezes; and I hope it will freeze; for, though I don't like the cold, I shall like very much to try this experiment; and I have a little bottle, and I will fill it with water, put it out of my window, and in the morning I dare say we shall find it burst."

"So it will," said Harry, "if the neck is narrow."

"But," said his father, "I can give you a bottle with a very wide neck; if you fill this with water up to the neck, either the bottle will break, or the ice will not only fill the bottle, but will shoot up through the neck of the bottle like a stopper."

"But what you wanted to try, I thought, was whether water takes up less room than ice," said Harry; "so, to make the proof quite exact, you should take the very ice that has been frozen in the bottle, and melt it, that is, put heat to it; and then, when it is water again, try whether it takes up more or less room, or the same that it did before."

"Remember you must melt it with a gentle heat, else the heat might evaporate some of the water," said their father.

"We will take care, papa, and we will try all this," said Lucy. "I love trying experiments, especially when we do it together, and when you, papa, are interested about them as we go on."

"Yes, and I love to have something to do, and something to think of," said Harry.

"And something to feel eager to go to again the next day," said Lucy; "I like to feel curious to know how the thing will turn out."

"Well, now turn out of my way, my dear," said her father, "for you are so close to my elbow that I cannot whet my razor."

It happened this day that Lucy found, in one of her drawers, a number of horsechestnuts, which she had collected in the autumn, and which she had intended to plant; but having forgotten them, they had lain in this drawer for nearly six weeks, and they had become a little mouldy. Lucy, finding that they were spoiled, threw them into the fire. A few minutes after she had thrown them into the fire, she was startled by hearing a noise, as loud as the noise made by a popgun, and she saw bits of coal, and fire, and chestnut, thrown out on

the carpet, to the distance of a yard from the hearth While she was stooping to pick up these bits, another *pop* was heard, another chestnut burst, and more bits of coal or fire were thrown out, and one of them hit her arm and burnt her a little. Nobody was with her—she ran into the next room directly, knowing that her father was there, and she called him, and told him what had happened, and asked him what she should do. He went immediately, and took all the chestnuts out of the fire. Harry and his mother came while he was doing this: they were glad that Lucy had not been much hurt, and that no mischief had been done. Her father then explained to her the cause of what had happened; he told her, that the heat of the fire, mixing with the water in the wet or mouldy chestnuts, had turned the water into steam, which takes up more room than water; and that the steam, being confined by the outer skin of the chestnuts, had, to make room for itself, burst through that skin, and had caused this sudden explosion.

After having explained this to Lucy, her father gave her an account of an accident which had happened to him when he was a child. He told her that he had thought that he could make a large lead pencil, such as he had seen used for ruling children's copy-books;—accordingly, he put some lead into a fireshovel, and bid his sister hold it over the fire to melt. In the meantime he fixed upright a bit of elder-tree, out of which part of the pith had been scooped. The wood was not quite dry; when the lead was melted, he took the shovel from his sister, and poured it into the hole in the piece of elder from which the pith had been scooped: but, to his great surprise and terror, the melted lead was driven out of the wood with such force as actually to strike against the ceiling. None of the lead struck his face; but had he been looking over it, probably his eyes would have been burnt out.

"So you see, my dear Lucy," concluded her father, "that it is particularly necessary that children should be careful in trying experiments, as they are not acquainted with the nature or properties of the things with which they meddle. When I filled the bit of wet elder-wood with hot lead, I did not know or recollect that the heat of the lead would turn the water into steam, and the expanding suddenly of this steam would cause an explosion."

This story brought to Harry's recollection an account which his mother had read to him of another accident. Lucy had not been present when this was read, and her brother now ran for the book and showed her the passage. She began to read—and it was as follows:—

"'At the cannon-foundry in Moorfields—'"

Lucy stopped at the first line, and said that she did not know what was meant by a cannon-foundry, and she did not know where Moorfields is. Her father told her that Moorfields is the name of a part of London; and that a cannon-foundry is a place where cannon are made—a foundry is a place where metals are melted, and cast into different shapes. The word is taken from the French word *fondre*, to melt.

Lucy had seen a cannon; therefore now she quite understood this first line of what she was going to read: Harry was rather impatient at her requiring so long an explanation; but her father said she was right not to go on without understanding completely what she heard. Lucy then read—

"'At the cannon-foundry in Moorfields, hot metal was poured into a mould that accidentally contained a small quantity of water, which was instantly converted into steam, and caused an explosion that blew the foundry to pieces. A similar accident happened at a foundry in Newcastle, which occurred from a little water having insinuated itself into a hollow brass ball that was thrown into the melting-pot.'"

Lucy was astonished to hear that water, when turned into steam, could have such force; from the facts which she had just heard and read, she perceived that it is necessary to be careful in trying experiments, and that it is useful to know the *properties* of bodies, that we may avoid hurting either ourselves or other people.

This evening it was a frost. Harry and Lucy saw that the quicksilver in the thermometer was at the *freezing point*. They determined now to try the experiments which they wished to try, about ice and water. Their father gave them a wide-necked bottle, and Harry filled it up to the bottom of the neck, leaving the neck empty: but he did not cork it. At the same time, Lucy took a common lavender-water bottle, that had wide shoulders and a very narrow neck; this she also filled up to the bottom of the neck, leaving the neck empty. Harry next filled a common vial bottle up to

the mouth, stopped it closely with a cork, and tied the cork down strongly to the neck of the bottle. They hung all these bottles out of doors on the same place on the north side of the house.

Their father went this day to dine with a friend at some distance from home; he was not to return till the next day at dinner-time; so that the next morning, before breakfast, they missed their accustomed lesson from their father, for which they were sorry. Lucy observed that her father's room looked dismal without him: and as there was unusual silence there, which the children did not like, they went off to the gallery, and comforted themselves by making as much noise as possible, galloping up and down the gallery, and playing at hare and hound. It was snowing, so that they could not go out to look at their bottles; and it continued to snow for some hours, till long after the time when they had finished the day's lessons with their mother. At last the snow ceased; and, as the sun began to shine, the children were now afraid that the water in their bottles might, if it had been frozen, be soon thawed; therefore they put on their hats and greatcoats as fast as they could, and ran out to the wall on the north side of the house, and to the place where they had hung up their three bottles the *preceding* day. They found that the lavender-water bottle, and the bottle that was tightly corked, were broken; but the bottle with the wide mouth had not been broken. The ice had swelled out through the neck of the bottle, and some way above it, looking like a stopper. This bottle they brought into their mother's dressing-room, who put it upon a saucer in a warm place, and they left it there, that the ice might melt. In the meantime, they went to help their mother to paste some prints into a large paper book. They were longer at this work than they had expected to be; they had but just finished it when the dressing-bell rang; then they recollected suddenly their *experiment*, and they said they must go and look whether the ice was melted; but their hands were now covered with paste, and their mother advised them first to wash their hands and dress themselves, that they might be sure to be ready before their father should come home to dinner.

Harry and Lucy ran away, saying—"Which will be dressed first?" And in a few minutes they came hurry-

ing from their different rooms, eager to get to their mother's dressing-room.

"I'm ready! I was here before you!" cried Harry, bursting in.

"Gently, gently, my dear Harry," said his mother, "and shut the door after you."

"Lucy's coming in, ma'am—ha! Lucy, I was here first."

"But I had a great deal more to do, brother," said Lucy.

Her mother turned and looked at her as she came into the room, and observed that Lucy's hair was not combed smoothly, and that one of her shoes was untied—

"And your hands, Lucy!" said her mother, "they are not clean—what is all this upon your hands?"

"Only the paste, ma'am, with which I was pasting those prints; but I did wash my hands, I assure you, mother."

"Yes; but you did not wash them well, I assure you, daughter—so go and wash them again before you do any thing else; you must not neglect to keep yourself clean and neat. This pocket-hole of your frock is torn almost from the top to the bottom."

"Yes, mamma; I tore it as I was coming down stairs; it caught upon a nail in the passage."

"Go and put on another frock, and mend this pocket-hole, before you do any thing else, Lucy," said her mother:—"It is more necessary that a girl should be clean and neat, than that she should try experiments."

Lucy blushed, and went away to do what her mother desired.

"Mamma, I am sure it was partly my fault," said Harry, "because I hurried her too much: but, to make amends, I know what I will do for her."

Then he ran for a pair of pincers which his father had given to him; with some little difficulty he took the nail on which Lucy's frock had been caught out; and with some little difficulty, Lucy washed the paste off her hands, and mended her frock.

When they went to look at their experiment, they found that the ice which they had left in the bottle was quite melted, and that the water had sunk to the place where it had been before it was frozen. The top of the water just came to the bottom of the neck of the bottle.

So they were convinced that water takes up less room than ice; or, in other words, that water, when it is frozen, takes up more room than it does when it is not frozen. When their father came home this day to dinner, Harry and Lucy told him the *result* or end of their experiments; and they said that the experiments had turned out just as he had foretold that they would. Their father said that he was glad that they had tried the experiments, and had satisfied themselves of the truth.

After dinner the children ran eagerly for the wide-necked bottle, that they might show their father that the water was *really* exactly at the place where it was before it had been frozen. They had left the bottle on the hearth, in their mother's dressing-room: and as they knew exactly the spot where they had left it, they thought they could find it without a candle, especially as they expected that there would be a little glimmering light from the fire in the dressing-room. However, the fire being almost out, they could scarcely see their way; they felt about near the corner of the chimney, but no bottle was there; they felt water on the hearth.

"Oh! our bottle is broken!" exclaimed Lucy—"Who has done this?"

"Are you sure it is broken?—maybe it is not," said Harry; "I will open the shutters, and then we shall see by the moonlight."

He drew up the curtain, unbarred and opened the shutters; then they saw, alas! that their bottle was broken. The dog was lying before the fire, and, in taking his customary place, had thrown down the bottle.

"Oh, our dear, dear, wide-necked bottle, with which I intended to do so many things!" cried Lucy.

"Fy! fy! naughty dog!—down! down, sirrah!" cried Harry, as the dog, now awakening, attempted to leap up and caress him!—"Down, sirrah!"

"But don't call him *sirrah!* Don't be in a passion with him," said Lucy:—"He did not know—he did not mean to do us any harm: it was our fault for leaving the bottle here just in his way. Come here, poor fellow," added she, as the dog was slinking away ashamed. Harry, ashamed too of his anger, joined Lucy in patting him, and both he and his sister were now pleased with themselves for bearing their disappointment with good-humour. The moon shone full on the window, and Harry, as he went to close the shutters again, call-

ed Lucy to look at "the beautiful sky, and the glorious number of bright stars in the heavens."

Lucy, as she looked and admired them, recollected something she had read in Sandford and Merton, about the names and places of the stars; the *polar star*, and *Charles's wain*, and the *great bear*, and the *little bear*. At the time when she had read it she had not understood it, because she had never observed the places of the stars in the sky; but this night she and Harry read over that part of Sandford and Merton again; and when they looked at the stars, and compared them with the description, they understood it perfectly:—they went on to read the account of the use which little Sandford made of his knowledge of the stars, when he lost his way one night in crossing a great moor between his father's house and his uncle's.

Harry and Lucy were glad that they had found something entertaining to read to themselves; because their father and mother were both engaged with their own employments this night, and could not attend to them. While they were reading, Lucy wanted her pencil to draw for Harry the figure of Charles's wain, and to make the map of the sky, with dots for each star, which Tommy Merton had proposed to make. But Lucy had not her pencil in her pocket; she had left it in her mother's dressing-room, on the chimney-piece, as well as she recollected, and when she went to look for the pencil by the fire-light, she saw the pieces of her broken bottle: she had a great mind to put them into the fire, for she knew that glass would melt if it was put into the fire. She recollected the print of the glassblower which she had seen in her "*Book of Trades*," and she wished much to see glass melted. But recollecting also at this moment that she had done mischief by throwing the chestnuts into the fire, she determined not to throw this glass into the fire without asking first whether it would do any harm. So she carried the broken glass carefully to the room where her father and mother were sitting, and she asked if she might put it into the fire. Her father, pleased by her prudence, was so good as to leave what he was doing to show Lucy what she wished to see. He put the bits of glass into the hottest part of the fire, and in a few minutes the glass became red-hot. Then he sent Harry to his workshop for a pair of pincers. Harry knew the names, and shape, and places

of all his father's tools; so he easily found the pincers, and he brought them. Lucy blew the fire till it became of a *white heat;* then her father took the thick part of the bottom of the glass out of the fire. It was now melted into a lump; he held it by one end with the hot tongs, and desired Harry to take hold of the other end of the glass with the pincers, and to try to pull it out as far as he could. To Lucy's surprise, the glass was now so soft and yielding, that Harry pulled it out as easily as he could have pulled out warm sealing-wax; and he drew out the glass across the little table at which his mother was sitting. When drawn out, the glass looked like a thin shining thread—like what is called *spun sugar* —that is, sugar which has been heated and melted, and drawn out in a *similar* (or like) manner.

Harry and Lucy were entertained by seeing this, and they asked several questions about the manner in which different glass things are made—they asked, for instance, how the panes of glass which they saw in windows are made; and how looking-glasses are made: and they wondered how the *cut glass*, or that which they saw in chandeliers, is made—but their father told them that they could not possibly learn so many things at once. That, perhaps, at some future time, he should have an opportunity of taking them to see a glasshouse, and of showing them how different kinds of glass are made.

"To-morrow, papa, will you take us?" said Lucy, "or next week?"

"No, neither to-morrow, my dear, nor next week—you must not see, or attempt to learn, a variety of things at once, else you will learn nothing well, but will only have a jumble of things in your head. Now go to bed, my dear children."

Then Harry put the pincers into their place, and threw the bits of glass into the fire; and Lucy put by their books, their pencil, and paper, and their map of the stars: they were careful to put all these things into their places, because their mother had advised them not to make it troublesome or inconvenient to show them experiments, or to let them amuse themselves in the same room with her and with their father.

"Now we have put all our things into their places, mamma," said Lucy; "and after we have gone to bed, you will not have the trouble of doing that for us. Good night. You will like that we should try experiments

another time, I hope, mamma, because we have not been troublesome."

In the morning, Harry and Lucy went to their father's room; and Harry observed that they had lost a day by their father's not being at home. "So now," added he, "we must make up for it, and *get on* to the barometer."

Lucy was at this instant mixing up the lather for her father, who was going to shave. She took a tobacco-pipe, and blew a bubble into the air; and when it burst, she said—

"Do, Harry, let me ask one more question about a bubble. Papa, when a bubble bursts, does the air which was withinside of it stay where it was, or what becomes of it?"

"I believe that it does not stay exactly in the same place where it was," said her father: "it spreads and mixes with the rest of the air in the room. It is supposed that when there is less air in one place than in another, the air which is collected in the place which contains the most of it, rushes into that which contains the least of it."

"But what makes some places fuller of air than others?" said Lucy.

Her father said that he did not know; but he reminded Lucy that air can be squeezed into a smaller space than it usually occupies.

"Why, it occupies the whole world, does it not?" said Harry.

"No, brother, not the whole world, you know; for stones, and trees, and animals have places in the world; but the air is all round us, and is in every place where there is nothing else."

"That is true, or nearly true, Lucy," said her father. "Harry, do you know any other name by which people sometimes call the air that is all round us?"

Harry said that he did not recollect any other name for it; but Lucy said that she believed the air round us is sometimes called the *atmosphere;* and she said she had heard people speak of the *pressure of the atmosphere,* but that she did not clearly understand what they meant.

"Take this hand fire-skreen, my dear," said her father; "move it upwards and downwards, and backwards and forwards. What do you feel?"

"I feel that I cannot move it quickly," said Lucy.

"What prevents you?—Let Harry answer."

"I believe it is the wind," said Harry.

"There is no wind in the room," said Lucy.

"But when she moves the skreen backwards and forwards I feel a wind," said Harry.

"It is the moving the skreen which puts the air in the room in motion. You will feel the air or atmosphere in any part of the room if you move against it," said her father. "Take this little parasol, open it—half—do not fasten it up; now run with it against the air, holding the outside of the parasol from you."

Harry did so, and found that as he ran, the parasol was closed by the air in the room, against which he pressed. Then his father bid him stand on a chair, and let the parasol fall when it was shut; and it fell quickly. He then opened it; and when it was open, Harry let it fall from the same height. It now fell very gently; and Harry perceived that it fell slowly, because, when it was open, it was resisted by the air underneath it in falling: he also observed that the parasol, as it fell, *made a wind*, as he said.

His father then cut out of a card the shape of a wheel; and he cut the card in several places from the outside, *or circumference*, towards the centre, and he turned these bits of cards sloping, so as to make a little windmill; he put a large pin through the centre of it, and stuck this pin into the uncut end of a pencil, so as to make a handle. Then he blew against it; and when he found that he could blow it round easily, he gave it to Lucy, and opening the window, desired her to hold it against the air at the open window, which, rushing in suddenly, turned the little windmill. Then he shut the window, and bid Lucy run with the windmill, as fast as she could, from one end of the room to the other, holding it in such a manner that it might press against the air as she ran. She did so, and the windmill turned quickly; then she and Harry perceived that the forcing and pressing against the air made the windmill turn round in the same manner as it had done when the wind blew against it.

"Harry," said his father, "take these bellows—blow the fire with them. What comes out of the *nose* or nozle of the bellows, as it is called?"

"Air, or wind," said Harry.

"What makes that wind?"

"My blowing the bellows," said Harry.

"What do you mean by blowing the bellows?"

"Making the bellows blow," said Harry.

"But how do you make the bellows blow?"

"By pulling up the top of the bellows and shutting it down," said Harry.

"Very true," said his father; "that opens the bellows, and makes room for air to go into them."

"The air," said Harry, "goes in at the large hole in the bottom of the bellows."

"It does so," said his father, "and some goes in at the pipe, or nose; but what hinders the air from going out of the large hole in the bottom where it went in?"

Harry said, "There is a little flap, or door, that shuts down when I blow the bellows."

"That little door," said his father, "or *valve*, as it is called, falls down by its own weight when you blow the bellows, and it shuts that hole; and the air which is then in the bellows goes out of the pipe into the fire. If I were to paste a piece of paper over the hole in the bottom of the bellows, what would happen?"

"The air," said Harry, "would come into the bellows at the nose when I lift up the top, and would go out again at the nose when I shut the bellows."

"Then," said his father, "what is the use of the hole at the bottom of the *valve*?"

"I believe," answered Harry, "it is to let the air in more quickly and more readily."

"It is so," said his father. "I will paste a piece of paper over the hole in the bottom of the bellows, and when it is dry, to-morrow, we will see what will happen. Now let me finish dressing myself."

This day was very cold, and the fire in the breakfast-room did not burn so well as usual. Harry's father, who was a man able to do things with his own hands, went for some dry wood, which he sawed into pieces of a certain length, convenient for putting on the fire. Harry could saw very well, and he assisted his father; Lucy stood by, and she asked him to let her try to saw. At first Lucy could scarcely move the saw; it seemed to stick in the wood, and she said she wondered how Harry could do it so easily. Harry showed her how to move

the saw, and guided her hand at first: and after a little practice, with some little patience, she got on pretty well. After she had sawed the branch in two, her father split it down the middle with a *cleaver*, or a little hatchet. He did not allow the children *yet* to meddle with the hatchet, lest they should cut themselves, as it requires some skill, care, and practice, to be able to manage a hatchet well.

Harry and Lucy wished that they might saw wood every day for the fire. They said that it would be pleasant work; and that it would warm them so well, and that it would be so useful! and they begged that their father would lend them a saw, and give them wood to saw, and a block or a *horse* to saw upon.

Their father answered:—"My dears, do you think that I have nothing to do but to get you every thing you want? I am afraid that if I were to take the trouble to provide you with these things, you would soon grow tired, and perhaps, after sawing half a dozen bits of wood to-day and to-morrow, you would throw aside the saw and forget it; as I have sometimes seen you throw aside and forget, or break, toys which delighted you the first hour or day you possessed them."

"Break! oh, father! my dear father!" cried Lucy, "*that* was only the foolish toy *that* lady gave me, which I could not make any use or any diversion of, in the least; after I had once looked at it, there was an end of it. I could not move the wooden woman's arms, or do any thing with her, so I forgot her, and left her on the floor; and the footman, by accident, put his foot upon her when he was bringing in coals. But, indeed, papa, I never break or forget my playthings, if I can play with them—there's my cart! I have had it a year, a whole year;—and there's my hoop—my battledoors and shuttlecock—my jackstraws—my cup and ball—and my ivory alphabet."

"And there's my cart, and my pump, and my bricks, and my top, and our dissected maps," cried Harry—"I am never tired of them, I know. And there is no danger, papa, that we should grow tired of a saw, if you will only be as good as to give us one; because it will always give us something to do; and, as Lucy says, we grow tired only of things that we cannot make any use of. Pray, papa, try us."

Their father was so kind as to grant their request:

he lent them a saw, and a *horse* that held the wood which they wanted to saw; and he allowed them to work in a little room, on one side of the hall, where there was no furniture, but which had been used as a sort of lumber-room. Here was kept a provision of wood for the winter, and there was plenty of branches which the children could saw: their father told them to saw these into pieces of about a foot or eighteen inches long; and he said, that when they were sawn into these pieces, he would have them split.

"Papa," cried Harry, "let us do it *all* ourselves. I can split them, I assure you; and we will take care not to cut ourselves, if you will lend us the little hatchet. Now, father, I will show you how well I can use the hatchet. Lucy may saw, and I will split."

Their father, however, would not lend them the hatchet yet. He told them that if they sawed only small branches, such as he would give them, these need not be split asunder afterward. They sawed this morning wood enough for the evening's fire. This evening they enjoyed the first fire made with wood of their own sawing—the first fire acquired by the labour of their own hands.

"Did you ever see such a delightful blaze in your life, mamma!" said Lucy.

"Papa," said Harry, "this fire has warmed us twice —I mean, the sawing the wood warmed us while we were at work; and now it warms us again while it is burning—mamma, would you be so good to begin to read about the way of walking in dangerous places, now Lucy and I are sitting so comfortably at your feet, and the fire is blazing so finely!"

Their kind mother smiled, and she began to read as follows:—

"'In the neighbourhood of Mount Pilate there are people who give lessons in the art of walking, as regularly as lessons in dancing are given elsewhere. It is of the greatest importance, in certain dangerous places, to know which foot to make use of, or which hand to use to preserve the balance of the body; and when you are to step on sharp pointed rocks, you must be sure when you are to put down your heel or your toe first: for want of instruction, or for want of attending to these instructions, you might fall down a precipice, or be obliged to remain in a painful attitude, without daring to

go forwards or backwards. * * * * The shoes usually worn on these mountains are merely soles of thin light wood, which are tied on the foot with leather straps; there are iron horseshoe nails at the bottom of the soles, which stand out from the sole near half an inch. The *mountain-climber* depends chiefly on his stick or pole. This pole must be light and pliable, and yet strong enough to bear the weight of a man, if it should happen, as it sometimes does, that the pole is stretched from one point of a rock to another, over the man's head, while he clings with both hands to it, as he passes beneath. The point of the pole is armed with iron at least two inches long.

"'When a man wants to go down a steep descent, he does not set out with his face turned towards the bottom of the hill, because his whole body would be out of a perpendicular line—'"

"Out of a perpendicular line!" interrupted Lucy—"mamma, I am not clear about *perpendicular* and *horizontal*—"

"No!" cried Harry, starting up; "then, my dear Lucy, I will make you clear about them in an instant, and for ever. Look," cried he, as he stood bolt upright, "now I am perpendicular; and now," continued he, throwing himself flat down on the carpet, "now I am horizontal."

"Thank you—now, mamma, I shall understand it."

"'The man's whole body would be out of a perpendicular line, so that when he advanced three or four steps, as the hill becomes steeper, he would fall forward; therefore, the man turns his side towards the bottom of the hill. In this position he has one foot higher than the other; if his left side is towards the bottom of the hill, his right foot must stand highest: this must be observed, that you may understand the manner in which he then makes use of his stick. He holds it sloping, with both his hands, one of its points resting against the ground; and this point must be above the place where his highest foot stands. The right hand must be at the bottom of the stick, and the left at the middle of it. In this attitude the man leans on the stick, with which he rakes or scrapes away the ground as he descends the hill. You may imagine with what swiftness he goes, and without the least danger; because his body, thus leaning on the stick, and approach-

ing the ground, there is no danger of falling. If, by chance, the man's feet were to slip, the weight of his body leaning on the stick, it is necessary only to slide the left hand, which was in the middle, towards the bottom of the stick. Then it is impossible that the man should slip far; because the stick, becoming almost perpendicular, and being grasped near the bottom by both his hands, it catches against the least obstacle or hollow in the ground; and this is sufficient to stop the man from sliding farther downwards.

"'In places where there are a great number of loose pebbles, as the most skilful walker might slide down along with the loose pebbles, two or three walkers join, and agree to go together: they provide themselves with a long pole, which they all hold with one hand: by these means, if one slips, the others hold him up. If all the party slip, which may chance to happen, he who first quits his hold of the pole is punished in whatever way the others think proper.'"

"My dear little Lucy," said her mother, putting down the book and looking at Lucy, whose eyes were closed, and whose head was nodding—

"My dear little girl, you are just asleep."

"Asleep!—O no, mamma, I am not asleep at all," cried Lucy, rousing herself.

"My dear, there is nothing shameful in being sleepy, especially at the hour when it is time for you to go to bed. Only do not let me read to you when you are sleepy, because you cannot possibly attend to what is read; and you would get the habit of hearing my voice going on, without minding or understanding what I say."

"O mamma! I beg your pardon; I assure you I heard the last words you read—it was something about *punished as they thought proper;* but I believe, mamma, I was sleeping a little too, for those words joined somehow with my dream, and I was dreaming about a saw, and sawing wood; and I thought that as I was sawing I slipped, and saw, and wood, and horse and all, slipped and were sliding down a hill; and just then I heard the words, 'punished as they thought proper.'"

"I know the reason she is so *shockingly* sleepy," cried Harry: "it is because she worked so hard this morning sawing; and she is not so strong, you know, as I am."

"There is nothing *shocking*," said his father, laughing—"there is nothing shocking in your sister's being sleepy. Good night, Lucy, my dear; go to bed—good night, Harry."

"No, papa, not good night to me, pray—I am not at all sleepy. I was thinking how I should like to live on that mountain, and slide down with my pole in my hand, and learn to walk in dangerous places. But here there are no precipices, papa; and I cannot learn to walk as they do on Mount Pilate."

"That is a lamentable case indeed, Harry," said his father; "but if you are so exceedingly anxious to learn to walk among precipices, I can tell you how a celebrated traveller says that you may learn to do it, even in this flat country."

"Can you, papa! O pray do tell me."

"Shut your eyes, and imagine yourself among precipices, and walk on; and M. de Saussure says, you may thus accustom yourself so to the idea of danger, that you would be much less terrified afterward, if you were among real precipices, than another person would who had never pursued this method."

"Is this true, papa!"

"I do not know, for I have never tried it. But I should think that you might practise walking over a narrow plank that was raised a foot from the ground, and, if you learn to balance your body and walk well upon that, if you were not afraid, you would be better able to walk steadily over any narrow bridge where there was a precipice or water beneath."

"So I could," said Harry: "and I will try this experiment to-morrow. There is a long ladder lying on the grass before the door, and I will walk on one side of the ladder, and Lucy on the other (for I suppose she will not be asleep to-morrow), and we shall see who slips first. Good night, mamma—good night, papa—and thank you."

Lucy was quite rested and refreshed when she awoke the next morning; and she went into her father's room with her brother at the usual hour.

The paper which had been pasted over the hole in the bellows was now dry; and Harry found that when he

lifted up the top, the air came into the bellows at the nose; but it did not come in so readily as when the hole in the bottom was open.

Harry's father now put a peg into the nose of the bellows, and desired Harry to blow. Harry, with great difficulty, lifted up the top of the bellows slowly. He knew that this difficulty was occasioned by the shutting up the opening at the valve of the bellows and at the nose; and he asked his father how any air could now get in.

His father told him that bellows cannot be so well made as to hinder the air from forcing its way into them at the place where the nose is fastened to the leather; and that, besides this, the air gets in between the leather and the wood.

"I see, papa, the paper which you pasted over the hole in the bellows sinks inwards," said Harry, "when you lift the top, and swells outwards when you shut it down."

"It does so, my dear; and if the other parts of the bellows were air-tight (as it is called), the paper would be broken inwards when I pull up the bellows."

"I suppose, papa, if it was not such strong paper, it would break now when you lift it up suddenly."

"It would, my dear:—I will wet the paper, which will make it softer and more *fragile*."

"What is *fragile*, father?"

"That which can be easily broken, Harry."

"Now you see, that lifting the top quickly has burst the paper."

"Yes, father, I see that the air, endeavouring to rush in, has broken the paper: the edges of it are all blown inwards."

"You perceive, then, Harry, that the air which is in the room, and everywhere else, is always forcing itself into any empty space; and that, if it cannot force its way immediately, it drives any thing before it which it can move into that space."

"But I want to know, papa," said Harry, "what makes the parts of air fly from each other?"

His father answered that he did not know; "But I do know," said he, "that, if heat be added to air, the parts of the air separate from each other to a greater distance, and with greater force, than when they are colder. Now, Harry," continued he, "I will close the

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valve or door of the bellows; and if we were to put the end of the bellows into this bowl of water, and if we were to open the bellows, what would happen?"

"The water would go into the bellows," said Harry.

"Why should it go in?" said his father; "the parts of water, you know, do not fly from each other in all directions, like those of air. If the bellows were lower than the bowl, the water might fall down into them; but you see that the bellows are higher than the water."

"I do not think," said Harry, "that the water would move itself into the bellows; it is the air on the outside of the water which would rush into the bellows, if the water were not in the way; the air drives the water before it, into the empty part of the bellows."

Harry's father then took a tumbler in his hand, and filled it with water, and said—"If this tumbler, that is full of water, be emptied of the water, the air that is in the room will enter into the tumbler, whether it be held in any part of the room, upwards, or downwards, or sidewise." He emptied the tumbler. "Now," continued he, "the air fills the space in the tumbler which the water did fill; and, whichever way I hold the mouth of the glass, whether upwards or downwards, to this side or to that, the air would go into it and fill it."

"So it is full of air at this very moment, is it?" said Lucy. "But how can you be sure of that, papa?—because we cannot see the air."

"No; but we can feel it," said Harry. "Wet your finger, and put it into the tumbler, and move it about quickly, and you will feel the air."

"I hope you are satisfied now," added he, laughing, as Lucy gravely put her finger into the tumbler, and said seriously,

"Yes, I am satisfied now."

"That is right, Lucy," said her father; "take nothing for granted. Now observe what happens when I put this tumbler, with its mouth downwards, into the water in this basin. Does the water withinside of the tumbler rise higher than the water on the outside of it, or does it not rise so high?"

"It does not rise quite so high," said Lucy.

"What do you think is in that space which you see above the water in the tumbler?"

Lucy at first hastily answered that there was *nothing*;

but, recollecting herself, she said there was air; and she just said the word air at the same moment when Harry said it.

"And now suppose that I should take away that air which is in the glass, immediately over the water—what do you think would happen when that air was taken away?"

Lucy said that she did not think that any thing would happen.

Harry said that he thought that the water would rise in the glass, and fill the place which the air had filled.

"Very right, Harry," said his father, "it would."

"Oh! to be sure, so it would," said Lucy; "but I did not say *that*, because I was thinking you meant quite a different sort of thing, papa, when you said, *what would* HAPPEN? I thought you meant to ask if any accident would happen—if the glass would be broken suddenly, or something of that sort. Oh, to be sure, I know the water would rise in the glass."

"And do you know, Lucy, why it would rise in the glass, or what would make it rise?"

Lucy could not tell; all she could say was, that the water would rise, because there was room for it to rise; but her brother said he believed that the air in the room, the air that was all over the water in this basin in which the tumbler is turned down, would press upon that water, and, by pressing it so, would force it up into the glass, if there was no air or any thing else in the glass to prevent the water from rising.

His father, without telling Harry whether he was right or wrong, said that he would try this for him.

But just then their mother came in, and told their father that breakfast had been ready some time; and she was afraid that, if he did not come soon, the muffins would be quite cold. Immediately their father made a great deal of haste to get ready. Harry smiled, and said—

"Ha! ha!—see what haste papa makes now he knows the muffins are come!—he loves muffins, I see, as well as I do!"

"I dare say he loves muffins, and so do I," said Lucy; "but I know, Harry, it is not all for the sake of the muffins that he is making this wonderful haste—there's another reason."

"What other reason?" said Harry.

"Because," whispered Lucy, "he loves mamma as well as muffins, and he does not like to keep her waiting for breakfast *always;* particularly when she is so good, you know, and is never angry."

"I wonder whether you will be as good when you grow up," said Harry, laughing—"No, no; I dare say you will frown this way at your husband, and say, 'I wonder, Mr. Slow, you are never ready for breakfast.'"

"Now, papa! this morning," said Harry, "I hope we are to see the experiment which you were going to show us yesterday, just when mamma and the muffins came. You know, papa, that you asked us what would happen if you could take away all the air that is in this tumbler, between the top of the water and the glass, and Lucy said *nothing* would happen; but she was wrong."

"Only at first, brother; I was only wrong at first, when I did not understand papa's question; afterward, you know, I was as right as you were, for I said the water would rise up higher in the glass, to be sure."

"Yes, but then you did not know the reason why it would rise, and I did; for when papa asked me, I said that the air in the room, the air that is all over the water in this basin in which the tumbler is turned down, would press upon that water, and force it up into the glass, if there was no air left in the glass to hinder it."

"Well, I know that," said Lucy, "as well as you."

"Yes, when I tell it you," cried Harry; "but I said it at first—I was right from the beginning."

"Come, come, my dear children, no boasting, Harry—no disputing, Lucy; and then you will both be right. What signifies which of you said it first, if you both know it at last? Now, Harry, turn your attention to this, and you, Lucy: I am going to try an experiment that will prove to you whether the water will or will not rise in the glass, when some of the air above is taken away."

"But I can't imagine, papa," said Harry, "how you will contrive to get all the air out of the glass."

"I cannot easily get all the air out of the glass—I cannot easily produce what is called a perfect *vacuum*, that is, a place where there is nothing, no air, or any thing else; but though I cannot produce a vacuum in

the top of this glass by taking away *all* the air, I can easily take away some of it."

"How, papa?" said Harry and Lucy at once. Their father answered—"You shall see."

Then he went for a crooked or bent tube of glass—it was nearly in the shape of a capital U—he told Harry that tubes of this sort are called syphons. He put one *leg* of this tube under the bottom of the tumbler, up through the water in the tumbler, into the place which appeared empty.

He now bid Harry suck at the other end of the syphon—Harry did so; and as fast as he sucked, the water rose in the tumbler; but when Harry took away his mouth, the water fell again.

"Why does this happen, Harry?"

"It happens, I believe, father, because, when I sucked, I took away the air that was above the water in the tumbler; and when I left off sucking, and took my mouth away, the air went again through the syphon into the tumbler above the water."

"Just so, Harry. Now the same thing would happen if I could take away the air, or lessen it by any means, in the tumbler. If I could fill or partly fill the tumbler with any thing that could be taken away from beneath the tumbler while it stands in the water that is in the basin, then we should see the water rise in the tumbler, in the same manner as if the air were sucked out of it. What shall we put into it that we can readily take out, without disturbing the tumbler?"

"I don't know," said Harry.

"Here," said his father, "is a little *spool*, or roller, upon which silk is usually wound.—Now I will put this into a little frame of tin, that will support it under the glass tumbler above the water. Upon this I have wound some very broad tape, so as to fill up a large space in the tumbler: I pull one end of the tape under the bottom of the tumbler, through the water that is in the saucer, so that I can unwind the whole of the tape without disturbing the tumbler. You see that the water rises in the tumbler as I unwind and draw out the tape; and, now that is all drawn out, the water has filled as much of the tumbler as had before been filled by the tape."

"That is very pretty," said Harry; "I understand it. When the tape was taken away, the room that it filled

would have been supplied with air, if air could have got into the tumbler; but, as it could not get in, it forced the water in the basin to go up into the tumbler."

"Now I will show you, my dear children, another method of trying this experiment. I make a little stand of halfpence under the tumbler, upon which I can put a piece of paper, without its being wet by the water in the basin—I set fire to the paper; and, while it is flaming, I put the tumbler quickly over the flame into the water—now, you see, the flame goes out, and the water rises."

"Yes, papa; I suppose the flame burns out some of the air."

"It does, Harry, consume a little of the air in the tumbler; but that is not the cause why so much water rises. You saw that the flame took up a considerable quantity of room in the tumbler while it was burning; but the moment that the glass covered the flame it went out, and then the room which the flame took up was supplied by the water rising from the saucer."

"Yes, papa, the water was driven in by the air that wanted to get into the tumbler."

"Just so, Harry. Now, instead of putting a piece of lighted paper upon the little stand of halfpence, I put a piece of tow, dipped in turpentine, upon it; this, you see, makes a larger flame; and when this is extinguished or put out by placing the glass quickly over it, more water rises than in the former experiment: and if I were to dip the tow into spirit of wine, and light it, it would answer the same purpose as tow dipped in turpentine."

Their father warned the children against the danger of having more than a very small quantity of turpentine or spirit of wine brought near to the candle or to the fire, as it might easily catch fire, and set fire to their clothes, or to the furniture in the room. "All experiments in which fire is necessary," their father said, "children should never attempt to try when they are in a room by themselves. Some grown-up person should always be present to prevent accidents, or to assist, if any accident should happen."

The children both promised their father that they would take care never to meddle with fire when he or their mother was not present, or to try any dangerous experiments.

Harry then turned again to look at the tumbler, and repeated that it was really very pretty to see the water rise in the tumbler, pressed up by the air that was over the water in the basin. Harry seemed still doubtful whether Lucy understood it.

"You see, Lucy, the air presses this water first, and that presses it up into the tumbler."

"Yes, I understand it perfectly," said Lucy.

"But, Harry," said his father, "you say that the air presses the water in the basin up in the glass tumbler. What do you think would happen if there was no water in the basin?"

"I believe the water would run out of the tumbler," said Lucy.

"So it would," said her father, "unless the bottom of the tumbler was ground quite smooth, and the basin also ground quite smooth."

"And what would happen if the basin and tumbler were ground quite smooth?" said Harry.

"Then," replied his father, "if you lifted up the tumbler, the basin would come up with it from the table, and seem to stick to it."

"I should like very much to see that experiment," said Lucy; "but we have no glass vessel or basin ground smooth enough, I believe."

"No: but I can show you an experiment, equally satisfactory, without them," said their father.

"I fill this ale-glass with water, and I cover it with a card, having first wetted the side of the card which is next to the glass—I now put the palm of my hand on the card, and I turn the glass upside down on the card, which lies on my hand. You now see that, though I have taken away my hand, the card sticks to the glass."

"That is very pretty!" cried Lucy.

"But why does not the water fall out?" said Harry.

"Because the card keeps it in," said Lucy.

"Why does it keep it in?" said Harry.

"Because the card sticks to the glass?" said Lucy.

"And what makes it stick to the glass?" said Harry.

Lucy did not answer immediately; but her father asked Harry if he knew.

Harry said it did not stick to the glass; "but it is held close against the glass by the pressure of the air that is in the room."

"That is quite right," said his father; "by the pres-

sure of the atmosphere. I am glad, Harry, that you know that the air presses upwards as well as downwards, and sidewise, and in all directions."

"Father," said Lucy, "will you be so good as to try that experiment again?"

"Here you see the card remains close to the bottom of the glass," said their father.

"But, father, the glass is not full?" said Lucy.

"Yes, it is full," said Harry; "though it is not quite full of water, it is full of water and air."

"I left it so on purpose," said his father. "Now I will hold it to the fire, and you will see what will happen."

In less than half a minute they saw the card drop off, and the water fall on the hearth.

"What is the cause of that?" said his father.

"The heat of the fire swells or expands the air that is in the glass over the water, and forces it and the card downwards," said Harry.

"There was also a little steam formed," said Lucy.

"There was," said her father. "Now let us take care, and not be late at breakfast this morning."

The children went to tell their mother of this last experiment, which pleased them particularly.

As soon as Harry and Lucy had finished their lessons this day, they went into what they now called "*their wood-room*," and sawed the provision of wood for the evening fire; and this day Harry's father lent him a little hatchet for a few minutes, while he stood by to see whether Harry would be able to use it without hurting himself. Harry split half a dozen billets of wood, and begged that, as he had done no mischief to himself, or to anybody, or any thing else, he might have the hatchet the next day, to split the wood in the same manner. But his father said—

"It is not likely that I should have time to stand by to-morrow to see you split wood, though I happened to have leisure just now; and I cannot yet trust you with the hatchet when you are alone. But, Lucy, what makes you look so blue? you look as if you were very cold; I thought you had warmed yourself with sawing."

"No, papa; because I have not been sawing. Harry had the saw—you know that two of us could not use the saw at the same time; and so I had nothing to do but to give him the wood when he wanted it, or to hold it for him when he was sawing; and that, you know, papa, was very cold work—this is what makes me look so blue, I suppose."

"Well, to-morrow you shall saw, and I will hold the wood," said Harry, "or we will take it by turns, that will be better; you shall begin, and saw one stick through, and I will hold the wood; then I will saw, and you shall hold the wood: that will be fair, will not it, papa?—Quite just—I must be just, to be sure."

"Yes," said his father. "In your code of laws for the children on Mount Pilate, do not forget that—nobody can govern well that is not just."

"That's true," said Harry, looking very thoughtfully. —"Now which must I put first, honesty or justice?"

"I think—" said Lucy, and she paused.

"What do you think, my dear?" said her father.

"I was going to say that I thought that honesty is only a sort of justice."

"You thought very rightly, my dear—it is so."

"And what are you thinking of yourself, may I ask you, papa?" said Lucy; "for you looked at the saw as if you were thinking something more about your sawing."

"I was so," answered her father—"I was just thinking of a way by which you could both saw together with the same saw."

"How, papa?"

"Invent the way for yourself, my dear."

"*Invent*, papa!—can I *invent?*" said Lucy.

"Yes, my dear; I do not know of any thing that should hinder you. To invent, you know, means—what does it mean, Lucy?"

"It means—to invent means to—think," said Lucy; "but that is not all it means; for I think very often without inventing any thing—it means to contrive."

"And what does to contrive mean?"

"It means to make a contrivance for doing any thing. O papa, you are going to ask me what a contrivance means—stay, I will begin again—to invent means to think of, and to find out a new way of doing something that you want to do."

"Well, now try, if you can, to invent some way of using this saw, so that you and your brother could work with it at the same time. Harry, think of it too; and whichever thinks of any thing first, speak."

"Papa," said Harry, "I recollect, the day we went to the farmer who lives on the hill, Farmer *Snug*, as Lucy and I called him, our seeing two men sawing in a sort of pit."

"I remember it," cried Lucy; "and papa told me it was called a sawpit."

"And one of the men stood on a board that was across the top of the pit, and the other man stood at the bottom of the pit, and they had a kind of saw that was fixed upright, perpendicularly, this way, in a sort of frame, and one of the men pulled it up, and the other pulled it down, through the wood they were sawing. Now, if Lucy and I had such a place to saw in, or if I stood upon something very high, and we had another handle to this saw—"

"But, brother," interrupted Lucy, "what would be the use to us of pulling the saw up and down that way? if we had but a handle at each end of this saw, why could not we saw with it, pulling it backwards and forwards, just as we stand now, without any thing more?"

"Very true, Lucy," said her father; "now you have found out or invented a kind of saw which was invented long ago by some one else, and which is at present in common use—it is called *a crosscut saw*: I will get you a crosscut saw. Now put on your hats; I am going to walk to see Farmer *Snug*, as you call him, about some business of my own; and you may both come with me."

Harry and Lucy got themselves ready in a minute, and ran after their father, who never waited for them. When they came to the farmer's house, while their father was talking to the farmer about his business, they ran to the sawpit, in hopes of seeing the men sawing; but no men were at work there. As they returned, they heard the sound of men sawing in a shed near the house, and they looked into the shed as they passed, and they found two men sawing the trunk of a tree across, with something like the sort of saw which Lucy had described to her father. They went back to Farmer Snug's to tell this to their father; but he was busy talking, and they did not interrupt him. While he was engaged

with the farmer, Harry and Lucy amused themselves with looking at every thing in the parlour and kitchen of this cottage. There was one thing in the parlour which they had never seen before. Over the chimney-piece hung a glass vial bottle, in which there was a sort of wooden cross or reel, on which thread was wound. This cross was much wider than the mouth or neck of the bottle; and Harry and Lucy wondered how it could ever have been got into the bottle. As they were examining and considering this, their father and the farmer having now finished their business, came up to them.

"Ah! you've got *that there ou'vous* thing, that reel in the bottle," said the farmer; "it has puzzled my wife, and many a wiser person, now, master and miss, do you see, to find out how that reel, thread and all, was got, or, as I say, conjured into the bottle. And I don't doubt but I might ha' puzzled myself over it a long time as well as another, if I had not just happened to be told how it was done, and after to see a man doing it, as I did, for a shilling."

"Oh, how I wish I had been by," cried Harry.

"And I too!" said Lucy. "Pray how was it done, sir?"

"Why, master—why, miss, you see just this way, *very ready*. The glass was, as it were—before it come to be a bottle *like* at all—was taken, and just blown over it, from a man's mouth, with fire and a long pipe. While they *was* shoeing my horse at the forge, the glasshouse being next door, I stepped in—so I did."

Harry and Lucy stood looking up in the man's face, endeavouring to understand what he said! but as Farmer Snug had not the art of explaining clearly, it was not easy to comprehend his descriptions.

"Then I will tell you what, master," said the farmer, growing impatient at finding that he could not explain himself, "it is an *impossibility* to make a body comprehend it rightly, except they were to see it done; and the man who did it is in our market-town here hard by. He is a travelling kind of a strange man, who does not speak English right at all, not being an Englishman born, poor man! no fault of his!—so, if you think well of it, sir, I will bid him, when I go betimes to market, call at your house to-morrow—he is going about the country, to people's houses—he blows glass, and mends weather-glasses, and sells 'mometers and the like."

"Weather-glasses!—barometers!" said Harry—"Oh, pray, papa, do let him come!"

"Thermometers—he sells thermometers, too!" cried Lucy—"Oh, pray, papa, let him come!"

Their father smiled, and said that he should be obliged to Farmer Snug if he would desire this man to call; and he begged that he would call in the morning, at half past nine o'clock, if he could. The family usually breakfasted at ten.

So much for the pleasures of this morning. This evening, Harry and Lucy's father and mother were reading to themselves; and the children entertained themselves with putting in some more stars into their map of the sky; and they looked at the great celestial globe which their mother had uncovered for them, and they learned the names of the signs of the zodiac, and the months to which they belong. Lucy showed these to Harry, and said—

"Mamma does not know them all herself; let us get them by heart, and surprise her."

Accordingly, they learned them with some little difficulty.

After they had learned these, Harry and Lucy refreshed themselves by playing a game at *jack-straws*, or, as some call them, *spilikins*. Lucy had taken off almost all the straws without shaking one, and, according to the rules of the game, would, consequently, have been victorious; but unluckily, a sudden push backward of her father's chair shook her elbow, shook her hand, shook *jack-straw*, just as she was lifting him up, and he fell!

Harry, clapping his hands, exclaimed—

"There!—you shook!—you shook!—you've lost."

Lucy looked at her brother and smiled.

"She has lost the game," said their mother; "but she has won a kiss from me for her good-humour."

Lucy, indeed, bore the loss of her game very good-humouredly; and, when she went to wish her father and mother good night, they both kissed her and smiled upon her.

"The barometer-man is to come to-day, papa, at half after nine, and it is half after eight now, papa. Will you get up?" said Harry.

"The man who can show us how the reel was put into the bottle," added Lucy. "Will you not get up, papa?"

Their father rose and dressed himself; and, as he was dressed by nine o'clock, they had half an hour to spare before the time when this *much-expected* man was appointed to come.

"Why should we waste this half hour, Harry?" said his father; "let us go on with what we were talking of yesterday morning. Do you recollect the experiments we tried yesterday?"

"Certainly, papa," said Harry; "you mean the experiments you showed us with the burning tow and the turpentine, to make an empty space—a *vacuum*, I remember, you called it—in the tumbler, that we might see whether the water would rise and fill the place which the air had filled. Yes, papa, I remember all this perfectly."

"And I remember the experiment you tried with the roll of tape, papa, which you put under the glass. When you unrolled the tape, and pulled it gently from under the tumbler, the water went up, and took the place of the tape that was unrolled."

"But, papa!" cried Harry, "I have thought of something!—I want to ask you a question, papa."

"Ask it then, my dear; but you need not begin by telling me that you want to ask a question."

"What I want to say, papa, is this—"

"Think first, my boy, and when you clearly know what you mean to say, speak; and begin without that foolish preface of *what I want to say is this.*"

"What I want," Harry began from habit, but stopped himself, and began again—

"Would the water run up into a very high vessel, papa, as well as it ran into the tumbler, if you suppose that some of the air in the high vessel were taken out of it?"

"Yes," answered his father; "if the vessel were as high as the room in which we are, the water would remain in it if it were quite emptied of air."

Harry asked if it would stay in the vessel were it as high as the house.

"No, it would not," answered his father; "because the pressure of the *atmosphere* is not sufficient to hold up the weight of such a column of water as could be contained in a pipe forty feet high, though it is suffi-

cient to *support*, or *sustain*, or hold up, the water that could be contained in a pipe thirty-four feet high."

Harry said he did not understand this.

"I am not surprised at that," said his father; "for you are not used to the words *pressure of the atmosphere*, or *column of water*, and to other words which I make use of. But," continued his father, "if we had a pipe forty feet long, with cocks, such as are in tea-urns, fitted well into each end of it, and if the pipe were placed upright against a wall, with the bottom of it in a tub of water, and if the lower cock were shut, and if the upper cock were opened, the pipe might, by means of a tundish or funnel, be filled with water. Now, Harry, if the lower cock were open, what would happen?"

"The water would run out at the bottom," answered Harry, "and would overflow the tub."

"True," said his father.

"But now suppose the pipe were filled again with water, and if the cock at the top were shut, and the cock at the bottom opened, under water, would the water in the tube run out?"

"No, it would not," said Harry; "the pressure of the atmosphere at the bottom of the pipe would prevent it from falling out."

"That would be the case," said his father, "if the pipe was only thirty-three or thirty-four feet high; but this pipe is forty feet high, so that the water in six feet of the top of the tube would run out; and, if this were let to run out very gently, the water in the remaining thirty-three or thirty-four feet would continue supported by the *pressure of the atmosphere* on the water in the tub."

"Papa," said Lucy, "there is a tub of water in the area under the window in my room: and this would be a fine way of raising water up into my room, without the trouble of carrying it up stairs."

"My dear, that is an ingenious thought," said her father; "but you are mistaken. I will not attempt at present to tell you exactly how—"

"Here is the barometer-man, papa!" interrupted Lucy. "I saw an odd little man, with a box under his arm, go by the window. Hark!—There he is, knocking at the door."

The man was shown into a room, which was called the workshop. He was a little, thin man, with a very

dark complexion, large black eyes, and, as the children observed, had something ingenious and good-natured in his countenance, though he was ugly. Though he could not speak English well, he made them understand him by the assistance of signs. He began to open his box, and to produce some of his things; but Harry's father asked him to rest himself after his walk, and ordered that he should have breakfast brought to him.

Harry and Lucy despatched their breakfast with great expedition; they thought that their father and mother were unusually slow in eating theirs, and that their father drank an uncommon number of dishes of tea; but at last he said—"No more, thank you, my dear;" and, putting aside the newspaper, he rose, and said—

"Now, children, now for *the barometer-man*, as you call him."

"Mamma!—mamma!—pray come with us!" said the children: they took her by the hand, and they all went together.

"Now, mamma, you shall see what Farmer Snug described to us yesterday," said Lucy.

"No—what he could not describe to us yesterday, you mean," said Harry. "How a reel, or a kind of wooden cross, mamma, is put into a bottle, or how the bottle is made or blown over the reel. I do not understand it *quite* yet."

"So I perceive, my dear," said his mother, smiling.

"But this man will show it to us, mamma," said Lucy. "And I generally understand what I see, though I often do not understand what I hear."

Alas! to Harry and Lucy's great disappointment, this man, when they had with great difficulty made him understand what they wanted, told them that he could not blow a bottle, such as they had seen at the farmer's, without being in a glasshouse, or without having such a fire or furnace as there is in a glasshouse.

This was a sad disappointment!—and, what Harry thought still worse, the man had sold all his barometers. However, he had some little thermometers, and Lucy's mother bought one for her and gave it to her. Lucy coloured all over her face, and her eyes sparkled with pleasure, when her mother put it into her hand, and Harry was almost as glad as she was.

"Is it really for me!—for my own, mamma!—I will take care and not break it. Harry, we can hang it up

in our wood-room, and see every day how cold or how hot the room is before and after we begin to work—and we can try such a number of nice experiments."

"Pray, sir," said Lucy to the man, "how do you make these thermometers?"

The man said he would shew her; and he took out of his box some long tubes of glass, and a long brass pipe, and a lamp. It was a lamp with which he could melt glass. When he had lighted his lamp, it made a large flame, which he blew with a brass pipe that he held in his mouth. Her father told her that this pipe was called a blowpipe. With it the man blew the flame of the lamp, and directed it to one of the glass tubes which he held in his other hand. In a little time the heat began to melt the glass, and it melted into a round ball; this he heated again in the flame of the lamp, and when the glass was soft and melting, he closed that end of the pipe, and it looked like a lump of melted glass; then he blew air in with his mouth through the other end of the glass pipe, till the air blown withinside of the pipe reached the end which was melting; and the air being strongly blown against it, it swelled out into a bubble of melted glass, and thus made the bulb of a thermometer-tube—he left it to cool very slowly, and when it was cool it became hard, and was a perfect thermometer-tube.

Harry's father had some *syphons* and bent tubes of different shapes made for him. Harry was very glad of this; for he thought he could try many different experiments with these.

The thermometer-man now was paid and dismissed.

As soon as he was gone, Harry and Lucy went to their usual occupations; for they never missed any day their regular lessons. Then came sawing wood—then walking out. Happy children! always doing something useful or agreeable.

This evening, when they were sitting round the fire after dinner, and after his father had finished reading the newspaper, when he was not busy, Harry asked him what glass is made of.

"I thought you had known that long ago, Harry," said his father. "Surely I have told you, have not I?"

"Yes, papa, I believe—I dare say you have; but I always forget; because I never was very curious or much interested about it till now; but now, when we

have been seeing, and thinking, and talking so much about glass, I think I shall remember what it is made of if you will be so good as to tell me once more."

His father desired Harry to bring him some sand, which was lying in a paper in his study. Harry did so. Then his father said to his mother—

"I wish I had some alkali to show the children—some barilla ashes—have you any in the house?"

"No."

There were no barilla ashes; but she recollected that a heap of fern and beanstalks had been lately burnt near the house, and the ashes of these were to be easily had.

Some of these ashes were brought upon a plate; and Harry's father placed the ashes and the sand before him, and said—

"These, when burnt together, would make glass."

"I shall never forget it," said Harry. "Now I have seen the real things of which glass is made, I shall never forget them."

"That is what I say too," cried Lucy; "seeing things, and seeing them just at the very time I am curious about them, makes me remember easily, and exceedingly well."

"Taste these ashes," said their father—"this *potash*, as it is called; wet your finger, take up a little of it, and put it into your mouth."

Harry and Lucy did so; but they said the ashes had not an agreeable taste. Their father said that he did not expect that they should think it agreeable, but that he had desired them to taste the ashes that they might know the taste of what is called alkali—what is called an *alkaline taste*.

"I shall not forget *that*, either," said Lucy.

"How wonderful it is," continued she—looking first at the sand and ashes, and then at a glass which she held in her hand—"how wonderful it is that such a beautiful, clean, clear, transparent thing as glass could be made from such different looking things as sand and ashes!"

"And I wonder," said Harry, "how people could ever think, or invent, that glass could be made of these things."

"Some say that glass was invented, or rather discovered, by a curious accident," said his father.

"Pray, papa, tell us the accident."

"Some sailors, or some merchants, who were going on a voyage, were driven by contrary winds out of their *course* (or way). They were driven close to land, and they were obliged to go on shore—the shore was sandy, and there grew near the place where these men landed a great deal of seaweed. The men wanted to boil some food in an iron pot which they had brought on shore with them; they made a fire on the sands with seaweed; and they observed that the ashes of this seaweed, mixed with the sand and burned by the fire, had a glassy appearance. It looked like a kind of greenish glass. It is said, that from this observation they formed the first idea of making glass by burning ashes of seaweed (called *kelp*) and sand together."

"How lucky it was that they made this fire on the sand with seaweed!" said Harry.

"How sensible those people were to observe what happened when they did so!" said Harry's father.

Next morning, when Harry and Lucy went into their father's room, Harry began with his usual speech—

"Now for the barometer, papa!—and," added he, "we must make haste, for we are to go to-morrow to my uncle's, and I must understand it quite before I see him again—we must make haste, papa."

"Let us go on quietly from where we left off yesterday," said his father.

"Yes, about the long pipe," said Harry.

"Pray, papa," said Lucy, "when you were speaking of the water staying in the pipe, why did you say that the water would be held up or sustained by the pressure of the atmosphere to thirty-three *or* thirty-four feet high in the tube? Why should you say thirty-three *or* thirty-four feet? Would it not stay either at the one or at the other of these heights?"

"That is a very sensible question, Lucy," said her father. "The reason is, that the *pressure of the atmosphere* is not always the same. In fine weather it is generally greater than when it rains or snows; and before it rains or snows, the *pressure*, or, as it is sometimes called, the *weight* of the atmosphere, is less than at some other times. So that, if we had such a pipe or

tube, and if the upper part of it were transparent, so that we could see into the inside of it, we could tell by the rising and falling of the water in the pipe when the air or atmosphere was heavier or lighter, and then we might *suppose* that the weather was going to change. I say *suppose*, because we should not be sure."

"Then, papa," said Harry, "if the top of this pipe were of glass, it would be a barometer, would not it?"

"Yes, my dear, it would. Now you know what a barometer is."

"Why do not people make such barometers as this?" said Harry.

"Because they would be very inconvenient," said his father; "in the first place, it would be difficult to place them so as that the rise and fall of the water could be easily seen, because you must go up to the top of the house every time you wanted to consult the barometer. In the next place, the frost would turn the water in the tube into ice; and there would be an end of the barometer. But the shining liquor that you saw in your uncle's barometer is not liable to freeze."

"That shining liquor," said Harry, "is called quicksilver, or mercury."

"Yes," said his father—"here is some mercury; feel the weight of it."

"The quicksilver that is in this glass, papa," said Lucy, "seems as heavy as all the water that is in that decanter."

"Yes," said her father—"mercury is more than fourteen times heavier than water. Now, Harry, if the pipe, forty feet long, which we were speaking of before, was filled with quicksilver, do you think that the pressure of the atmosphere would hold up the quicksilver thirty-four feet high?"

"Certainly not, papa," answered Harry; "because the quicksilver is so much heavier than water."

"Would it hold it up one quarter the same height?" said his father.

"No, it would not," answered Harry; "because it is easy to perceive that the quicksilver is more than four times heavier than the water."

"Very true, Harry. It has been found by experiment, that the pressure of the atmosphere will sustain a column of mercury about twenty-nine inches high; sometimes it will sustain only a column of twenty-

seven inches; and sometimes a column of thirty, more or less, according to the pressure of the atmosphere."

"How long is the tube of a barometer?" said Harry.

"It is generally about thirty-six inches long; but, as the mercury never rises to the top of the tube, there is always an empty space between the top of the mercury and the top of the glass, which allows the mercury to rise or fall as the pressure of the atmosphere is more or less. The glass tube of a barometer is about one fourteenth part as long as the leaden pipe which you said would make a water barometer; but the quicksilver is fourteen times as heavy as the water."

"All this is rather difficult," said Lucy.

"So it must appear to you, at first, my dear," said her father; "but when you have seen it often, and talked with your brother about it, you will understand it more clearly."

"But at least," said Lucy, "I know now, papa, what is meant by *the glass falling* and *rising*. It does not mean that *the glass* falls or rises, but that the mercury rises or falls in the glass."

"Very true, my dear Lucy; saying that the glass rises or falls is an inaccurate mode of speaking. Now, my dear boy, I think you will be able to understand your uncle's barometer when you see it to-morrow; particularly if you read to-night an excellent description and explanation of the barometer, which you will find in this little book," said his father, putting "Scientific Dialogues" into his hands; it was open at the word *barometer*.

"O thank you, father!" said Harry.

"And, my dear Lucy," said her father, turning to Lucy, and showing her, in a book which he held in his hand, a print, "do you know what this is?"

"A thermometer, papa!—Fahrenheit's thermometer—Oh, I remember what you told me about Fahrenheit's thermometer."

"I think you will be able now to understand this description of thermometers, my dear; and you may read it whenever you please," said her father.

"I please to read it this instant, papa," said Lucy.

So Lucy sat down and read, in the "*Conversations on Chymistry*," the description of the thermometer; and Harry read the explanation of the barometer, in "*Scientific Dialogues*." And when they had finished they

changed books, and Harry read what she had been reading, and Lucy read what Harry had been reading; and they liked the books, because they understood what they had read.

"I wonder what the rest of this book is about," said Harry, turning over the leaves; "here are many things I should like to know something about."

"And I should like," said Lucy, "to read some more of these conversations between Emma and Caroline, and Mrs. B——. There seem to be drawings here, and experiments too. Since papa has shown us some experiments, I wish to see more."

"But, my dear," said her father, "you are not able yet to understand that book. Look at the beginning of it. Read the first sentence."

"*Having now acquired some elementary notions of natural philosophy—*"

"What are *elementary notions?*" said Lucy, stopping short.

"I know," said Harry; "for I heard the writing-master, the other day, tell my father that he had given Wilmot, the gardener's son, some elementary notions of arithmetic, that is, first foundation notions, as it were."

"Then I have no elementary notions of natural philosophy—have I, papa?" said Lucy.

"In the first place, do you know what *natural philosophy* is, my dear?" said her father.

Lucy hesitated; and at last she said she did not know clearly—she believed it was something about nature.

Harry said he believed it meant the knowledge of all natural things—things in nature; such as the air, and the fire, and the water, and the earth, and the trees, and all those things which we see in the world, and which are not made by the hands of human creatures.

Their father said that this was partly what was meant.

"Then," said Lucy, "I have no *elementary notions of natural philosophy.*"

"Yes, you have," said Harry—"all we have been learning about the air, and the wind, and the pressure of the atmosphere, and all that papa has been showing us about water and quicksilver; these are elementary notions of natural philosophy, are not they, papa?" said Harry.

"Yes; but you have as yet learned very little," said

his father; "you have a great deal more to learn before you will be able to understand all that is in these 'Conversations on Chymistry,' and in 'Scientific Dialogues.'"

"Well, papa," said Harry, smiling, "that is what you used to say to me about the barometer; you used to say, a little while ago, that I must know a great deal more before I could understand the barometer; but now I have learned all *that*, and now I do understand the barometer; and, in time, *I* shall—*we* shall, I mean—know enough, I dare say, to read these books, and to understand them, just as well as we now understand the barometer and thermometer."

"Yes, and very soon too, I dare say!—shall not we, papa?" cried Lucy.

"All in good time: we will *make haste slowly*, my dear children," answered their father. "Now go and get ready as quickly as you please, to go with your mother and me to your uncle's."

EARLY LESSONS.

HARRY AND LUCY.

CONCLUSION.

PREFACE;

ADDRESSED TO PARENTS.

This concluding part of "Harry and Lucy" is intended for young people from the age of ten to fourteen. It completes the series of "Early Lessons;" an humble work, from which no literary fame can be acquired, but which I have been most desirous to complete, from the belief that it will be more useful than any other in my power. I have had another motive for finishing it; one which, though it may be no concern of the public, I may be permitted to name. Harry and Lucy was begun by my father, above fifty years ago, for the use of his own family, and published at a time when no one of any literary character, excepting Dr. Watts and Mrs. Barbauld, had ever condescended to write for children. That little book was, I believe, the very first attempt to give any correct elementary knowledge or taste for science in a narrative suited to the comprehension of children, and calculated to amuse and interest, as well as to instruct. Finding, from experience, that it answered the intended purpose, my father continued the book at intervals; and in the last part, published in 1813, I had the pleasure of assisting him. He then communicated many ideas for the completion of his plan, which I thought too valuable to be abandoned. I considered that a full knowledge of his views, and long habits of acquaintance with his mode of teaching, might enable me to do justice to his plan, though I was aware of the difficulty of combining ingenious with practicable illustrations, and still more sensible of the accuracy requisite for elementary instruction. The want of his mind working along with my own, I knew, must be in this attempt peculiarly felt; but I have been encouraged to persevere by the assistance afforded me by his and my own scientific friends. To name these kind and able friends would gratify my vanity, and might ensure the confidence of parents; but it would, perhaps, have more the appearance of osten-

tation than of candour, and might leave others responsible for errors which have escaped the most careful revisal.

I have endeavoured to pursue, in this Conclusion of Early Lessons, my father's object in their commencement—to exercise the powers of attention, observation, reasoning, and invention, rather than to teach any one science, or to make any advance beyond first principles. The essential point is to excite a thirst for knowledge, without which it is in vain to pour the full tide even to the lips. As Dr. Johnson said to Boswell when he was describing the pains his preceptors had taken to give him learning—

"Sir, anybody can bring a horse to the water, but who can make him drink?"

Consistently with the sort of instruction to be conveyed, it was impossible to give as much of the amusement arising from incident and story in this book as in some others. But the varying occurrences of domestic life, the frequent changes of scene, and the different characters of the children, with all their hopes and fears in the pursuit of their own little schemes and experiments, will, I hope, produce sufficient action to create interest, and to keep awake attention. No pernicious stimulus has been given, no deception or cajolery employed, to effect our purpose. All attempts to cheat children, by the false promise that they can obtain knowledge without labour, are vain and hurtful. The gods sell every thing to labour, and mortals, young or old, must pay that price. The wages of industry should, however, be rendered as certain as possible; for the pupils will exert themselves in proportion to their hopes that their efforts will be recompensed by the pleasure of success. I have taken all the precautions in my power to secure to each effort of attention its just reward.

Much that would be tiresome and insufferable to young people, if offered by preceptors in a didactic tone, will be eagerly accepted when suggested in conversation, especially in conversations between themselves: in these there is always a certain proportion of *nonsense*; an alloy which is necessary to make sense work well. Children can go on talking to one another much longer than they can bear to hear the address, however wise or eloquent, of any grown person. Young people of good

disposition learn with peculiar ease from each other, because the young teacher has not forgotten his own difficulties; knowing exactly where they lay, he sees how to remove them, or to assist another over the obstacles. The great preceptor, standing on the top of the ladder of learning, can hardly stretch his hand down to the poor urchin at the bottom, looking up to him in despair; but an intermediate companion, who is only a few steps above, can assist him with a helping hand, can show him where to put his foot safely; and, now urging, now encouraging, can draw him up to any height within his own attainment.

The system of mutual instruction can be still more advantageously pursued in teaching the rudiments of literature, and may be extended even to higher branches of intellectual education. Upon this principle, in the following pages, the young brother is employed to teach his sister what he has learned, either from his father, or from books.

Harry's abilities and knowledge will perhaps appear a little above his age; but this the reader must excuse, and attribute, as he pleases, to education, or to accident, or to natural genius. Harry will not be disliked because he is not pedantic; and he has some redeeming faults and foibles, which save him from the odium attached to a perfect character, and from the danger of being thought too good to be natural.

Lucy, on the other hand, may at times seem too childish and volatile; her respect for accuracy not being at first much greater than that of the sailor, who said, "We'll not quarrel for a handful of degrees." But these faults produce the nonsense and the action necessary to relieve the reader's attention. As to the danger and the penalties of her becoming an affected scientific lady, it is left to her mother's and her own good sense and good taste to guard against that evil. All that can be said or thought upon the subject by the other sex, is comprised in the Edinburgh wit's declaration—

"I do not care how *blue* a lady's stockings may be, if her petticoats are but long enough."

My father long ago foresaw, what everybody now feels, that the taste for scientific as well as literary knowledge, which has risen rapidly, and has spread widely, would render it necessary to make some provision for the early instruction of youth in science, in ad-

dition to the great and successful attention paid to classical literature. In public establishments, alterations, even when felt to be requisite, must for many reasons be tardy; much, in the meantime, may be prepared by private instruction.

It has been feared by some that the general diffusion of knowledge will tend to damp the energy of genius; and that original invention will decline, in consequence of increased cultivation. This might, perhaps, be the consequence of injudicious cultivation. If the acquisition of a great quantity of learning of all kinds, or of any kind, were made the sole and ultimate object, the mind would be oppressed, and invention extinguished under the mass: but of this there is no danger if the faculties be proportionably exercised, and if the pupil be enabled to arrange, and above all to employ, his knowledge. In science, the hope of future discoveries, and the ambition to invent, are great, natural, and never-failing excitements to young and old.

That very ingenious and very mysterious philosopher, Dr. Hooke, speaks somewhere in his works of an algebraic formula, by which he could determine what things are possible or impossible to perform or to invent. Without perfectly crediting or perfectly understanding this veiled prophet, we may hope and believe that the inventive power may be assisted and improved by exercise, by reasoning, and by judicious experiments. Many admirable observations on the nature and conduct of the understanding, on the causes which have prevented our advancement in knowledge, and on the habits of false reasoning, prepossessions, and prejudices, which enslave and disable our faculties, are to be found in the words of Bacon and of Hooke, of Locke, Stewart, and Playfair. These observations should not be suffered to lie dormant in books, the admiration only of the learned; nor should we be content with merely citing them occasionally, to adorn our writings, or to point our conversation. Metaphysics, after being too much in fashion, have been thrown aside too disdainfully, and their use and abuse have been confounded. Surely it would be doing good service to bring into popular form all that metaphysicians have discovered which can be applied to practice in education. This was early and long my father's object. The art of teaching to invent —I dare not say—but of awakening and assisting the in-

ventive power by daily exercise and excitement, and by the application of philosophic principles to trivial occurrences, he believed might be pursued with infinite advantage to the rising generation.

I have now stated all the objects of this work: how far they have been accomplished must be left to time, and parents, and, above all, to children, to decide.

MARIA EDGEWORTH.

May 31st, 1825.

HARRY AND LUCY.

[CONCLUDED.]

"MAMMA, do you recollect, two years ago, when my father was explaining to us the barometer and thermometer, and when he showed us several little experiments!" said Lucy, and she sighed.

"Yes, my dear, I remember that time very well," said her mother; "but why do you sigh!"

"Because I was very happy *then*," said Lucy.

"And are not you happy now, my dear?"

"Yes, mamma, but not so very happy as I was then, because now I do not *go on* with Harry as I used to do."

"How so! I hope that you have not had any quarrel with your brother?"

"Quarrel! oh no, mamma, it would be impossible to quarrel with Harry, he is so good-natured; and he is as fond of me as ever, I believe. But yet, I do not know how it is, we do not suit each other quite as well as we did. We are not so much together; I do not know all he is doing, nor go on with all he is thinking of, as I used to do."

"My dear Lucy, you and your brother have been learning different things for some time past; and, as you grow older, this must be; your different employments must separate you during a great part of the day; and so much the better; you will be the more glad to be together in your hours of amusement. Do not you find this!"

"Yes, I do, mamma," said Lucy, "but—" and after this *but* she sighed again. "But now we are not amused always in the same way. Harry has grown so excessively fond of mechanics, and of all those scientific things which he is always learning from my uncle and papa."

"I thought, Lucy, that you were fond of those things too!" said her mother.

"So I am, mamma; only I am not nearly so fond of them as I was formerly: I do not exactly know why;

but, in the first place, I suppose, because I do not understand them now nearly so well as Harry does: he has got very far before me."

"True," answered her mother, "you have been learning other things, which it is more necessary for a girl to know."

"Yes, mamma, I remember your saying just after that happy barometer time, that I thought of nothing but experiments; papa said that must not be. Then I was not allowed to go into his room with Harry in the mornings. However, I learned more of arithmetic, and drawing, and dancing, and music, and work."

"And you grew fond of these; so much the better," said her mother. "This does not make you less happy, does it?"

"No, no, mamma; but then came the time when Harry and I were quite separated. That long—long—long time, when you were ill, mamma, and when I was at my aunt Pierrepoint's: while I was with her I read nothing but stories and poetry, and I heard my aunt and people who were there reading plays. She used to praise me for understanding wit, and for repeating poetry. Then I grew very fond of them. But Harry is so grave always about wit; he never understands it at first; and at last he says, 'Is that all?'—As to similes, they always interrupt him."

"*They* interrupt him!" said her mother; "perhaps, Lucy, *you* interrupt him."

"Sometimes, perhaps, I do, mamma; but he always finds out that similes are not exact. This is very provoking. I wonder why he is so much fonder of exactness than I am."

"Probably because in science, which he has been learning, he finds at every step the use, the necessity of exactness. He could not go on without it in measuring or in reasoning."

"Mamma, I understand the use of exactness in some things. In drawing in perspective, and in proportion, by a scale, as you taught me. Harry came to me the other day, and asked me to draw a cart for him; and I was glad to find that I could help him in something."

"And I dare say he will be glad to help you in his turn. You each know different things, which you can learn from one another, and in which you can be of mutual assistance. This is just as it should be between friends."

"Thank you, mamma, you make me feel happy again. I will ask Harry to bring me up to him in all he has been learning, as fast as possible, that we may go on together as we used to do, if you have no objection, mamma."

"Do so, my dear Lucy; but I warn you that you should not expect to go fast; you must be content to go slowly, and you must submit to be inferior to your brother for some time. This may mortify you, my dear, but it cannot be avoided; you must bear it."

"Very well, mamma, I can bear it. But, mother," said Lucy, hesitating a little, "there is one other thing I want to say before I can be quite happy."

"Say it then, my dear: what are you afraid of?—Not of me, I hope!"

"Oh! no, mamma, not afraid of you; but I am not sure that the person who said what I want to tell you would like that you should know that he said it."

"You can tell me what was said, then, without telling me from whom you heard it. Cannot you, Lucy?"

"I can, and will," said Lucy. "Then you must know, mamma, that one day, when I was at aunt Pierrepoint's, she was telling *somebody* that papa used to teach me scientific things along with Harry; but that, since I had come to her, I had not learned any thing of that sort. And—now it comes, mamma; the gentleman, who is not to be named, laughed."

"Well, there was no great harm in that."

"No, mamma; only that he laughed in a particular sort of way, scornfully. And he said that it was well for me I had left off such *learning*. That I should be a much more agreeable woman without it; that ladies had nothing to do with science, or ought to have nothing to do with it. He said that scientific ladies are always displaying what they know, or what they do not know. Those were his very words. He said that scientific ladies were his *abhorrence*. And he looked as if he abhorred them terribly. I was very sorry at the time that he knew papa had taught me any thing along with Harry. I was ashamed and frightened, and I thought it was all wro[illegible] But now that I am come home I think that it was all right; for I see how much papa likes that you should know the scientific things that he is busy about, and how happy it makes you; and I want to go on again with Harry: only I wish, mamma, that all people were of the same opinions about *this*."

Her mother smiled, and said, "That can never be, my dear Lucy; you will find many people have different opinions upon this subject. But all will agree with your nameless gentleman, that when women pretend to understand what they do not, whether about science or any thing else, they are absurd and ridiculous. And if they talk even of what they understand, merely to display their knowledge, they must be troublesome and disagreeable. Therefore they should take care not to do so. They should be particularly cautious of talking on scientific subjects, because they seldom obtain accurate knowledge; they are therefore likely to make mistakes, and to be either troublesome in asking questions, or ridiculous in showing ignorance and conceit."

"That is," said Lucy, "if they *set up for* being scientific ladies."

"Yes, if they do that, they must take the consequences; they will be disliked," said her mother.

"But then, mamma, I am so much afraid of being abhorred. Even if they are not conceited, will they be abhorred, mamma?"

"Not by persons of sense, my dear," said her mother. "As far as I can judge, I think that sensible men would be ready to assist any unaffected, unassuming woman, who really wished to inform herself, and would like her the better for being interested in their conversation, their writings, and their pursuits."

"I hope then, mamma, that I shall be an unaffected, unassuming woman."

"I hope so, my dear child," said her mother. "If your father did not hope so too, he would never teach you any more on these subjects."

"I should be very sorry for that," said Lucy.

"Yes, I think you would, my dear; for, even with your little experience, you feel that there is a real pleasure in going on, as you say, with your brother."

"That I do, indeed, mamma."

"As you grow older," continued her mother, "you will perceive that, by acquiring knowledge, women not only increase their power of being agreeable companions to their fathers, brothers, husbands, or friends, if they are so happy as to be connected with sensible men, but they increase their own pleasure in reading and hearing of scientific experiments and discoveries; they acquire a greater variety of means of employing them-

selves independently and at home. But, above all, the acquisition of knowledge not only enlarges, but elevates the mind, by filling it with admiration and gratitude towards that bountiful Providence who has established such wise laws for the welfare and preservation of the world."

"Yes, mother," said Lucy; and, after a pause, in which she reconsidered all her mother had been saying, she returned to what still a little alarmed her imagination. "But yet, mamma, I feel afraid of being *abhorred*; and if the acquiring of knowledge should make me vain—there is the danger."

"There is the danger, to be sure," said her mother. "But, as far as I have observed, ignorant women are as vain, and often more so, than those who are well informed; and now, when almost all are so educated that they have a taste for literature, and some acquaintance with scientific subjects, there is less danger that any should be vain of what is no peculiar distinction."

"Oh, mother, I will take the greatest care," said Lucy; "you shall see as I grow up; and thank you for explaining all this to me."

"Perhaps, my dear, part of what I have been saying is rather above your comprehension?"

"No, mamma; not at all. If it is not conceited to say so, I think I understand it all perfectly well; and now I know what is right and wrong, and my mind is settled; and I am happy again, and very glad that I may have the pleasure of learning again from papa; and, above all, glad that I may *go on again* with Harry. And here he comes, mamma; I see him from this window, coming along the path from my uncle's. Oh, mamma! he has a great walking-stick in his hand, and he is hobbling like an old man of a hundred and ten."

"I hope he has not hurt himself," said her mother, coming to the window.

"No, mamma, I believe he is only in play. There! the old man is running as well as ever he did in his life; and I will run and meet him."

As soon as Lucy was near enough to make her voice heard, she asked her brother why he walked with his uncle's walking-stick, as she supposed it to be.

"It is not his," said Harry, "it is mine; my uncle has given it to me."

"Yours! and it is quite new; I never saw it before. How beautifully varnished! and what a pretty head!

But why did my uncle give it to you, Harry? It would be of use to him, and it will be of none to you," said Lucy.

"There you are mistaken; I beg your pardon, Lucy. It will be of as much use to me as it would be to him, and of the same sort of use," said Harry.

"Same sort of use!" said Lucy; "but of what sort?"

"Guess," said Harry.

"I suppose you mean in play, to act an old man, as you did just now?"

"No, in earnest, useful," said Harry.

"What *can* you do with it?" said Lucy, "for you are too young to walk with it, and too old to ride upon it."

"Too old! to be sure I am," said Harry, indignantly; "I have not ridden upon a stick these hundred years. Guess again."

Lucy now wanted to examine this wonderful stick more closely, in hopes of discovering what its merits might be; but Harry seemed unwilling to let it out of his hands.

"Oh! I know what it is. It is full of money. It is like the staff which the man had in the trial in Don Quixote, which Sancho Panza found out was full of money, because he would not let it out of his hands."

"I do not in the least know what you mean," said Harry, "for there is no money in this."

"Then let me look at it; I will not run away with it. How heavy it is," observed Lucy; "what wood can it be made of?—This outside seems to be mahogany, but I never felt any so heavy. It cannot be all wood; it must be hollow, and there must be something within-side of it."

"Stop! stop! do not shake it; do not turn it upside down; you will spoil it," cried Harry.

"Ho! ho! then there is something withinside of it. I have found that much out," said Lucy; "and you say, 'Do not turn it upside down,' like the words on the box of glass that came last week; '*Keep this side uppermost.*' So I guess that there is glass within your stick. You smile, there is! Glass!—Then perhaps it is a spy-glass?—a telescope?—a magnifying-glass?—a microscope? No, none of these! What can it be! Of what use can glass be in a walking-stick, Harry?"

"Of a great deal, as you will acknowledge when you

find it out. Guess again," said Harry; "it is a thing that you have seen."

"But I have seen so many things," said Lucy.

"And of which you know the use," said Harry.

"But I know the use of many things! Tell me a little more," said Lucy; "what is it used for?"

"For weighing *something*," said Harry; "stay, I am not sure that it is quite fair to say it is used for weighing a *thing*, and yet it is something."

"I know now," said Lucy; "that motion you made with your hand up and down against the air told me. The *something* that it is used for weighing is air, and it is a barometer."

"Now you have found it out," said Harry.

"And now I know what makes your stick so heavy," said Lucy: "the quicksilver—the mercury. I remember feeling the weight of mercury, when papa put into my hands two cups of the same size, one full of water, and the other full of mercury. How stupid I was not to think of this at first, and not to guess it was a barometer!"

Harry now showed where his walking-stick opened, and he showed her withinside of it a barometer and thermometer; he explained to her how the quicksilver was screwed up tight, so as to prevent it from shaking. He told her this was called a portable barometer.

"Yes, it is portable," said Lucy; "it can easily be carried from place to place. It must be convenient to travellers. But is it in any other way better than the barometer which hangs up in papa's room, or than that which stands upon three legs in my uncle's library?"

Harry said that he was not sure that it was better for common use, to show the changes of the weather; "but this," said he, "is not merely a weather-glass, as barometers are sometimes called. This is intended for another purpose."

"What other purpose?" said Lucy.

"First, let me tell you why my uncle gave it to me," said Harry; "because he was pleased with my having taken pains, two years ago, to understand the barometer, and with my remembering it now. Then he bid me try to find out the particular use of this portable barometer."

"And did you, Harry?"

"Yes, but I was helped. My father, who was present, put me in the right road. I was very stupid at

first. My head went quite off the wrong way, but my father was very patient, and brought it back again, and set it upon the right road. Still I was very slow. My uncle thought I should never find it out. He said it was too difficult, and that my father had better tell me. But papa said he was almost sure that I should find it out myself. This encouraged me, and I tried and thought again, and my uncle left off walking up and down the room fretting. He was so good as to be patient too."

"That was kind of him," said Lucy; "I know it is very difficult to be patient with people if they are slow in finding a thing out, when one knows it all the time. One longs to tell, or to push them on to it."

"Papa did not *push* me," said Harry, "that would have thrown me down; but he pulled, he helped me on gently, step by step, as he does so nicely; and he let me find it out at last quite by myself."

"Well, then, you can do the same for me, Harry."

"I will try," said Harry.

"Thank you. But first let me tell you all that I have been saying to mamma, and all that mamma has said to me."

She repeated it all, as well as she could, ending with, "Mamma tells me that I may *go on* with you, Harry, as we used to do; and she said she thought that you would be so kind as to bring me up to you in all you have been learning."

"I will try," said Harry.

"I hope I shall not be very stupid," said Lucy.

"No, no, Lucy, I dare say you will not; do not begin by thinking you will, that is a very bad way; because then you go on, thinking you are afraid you will be stupid, instead of attending to what is asked and said to you. Now, Lucy, suppose you were at the bottom of a deep well."

"If I were at the bottom of a well, then I should find out the truth; because you know the common proverb, as Mr. Cranbourne said, that truth is at the bottom of a well."

"Nonsense, my dear Lucy," cried Harry; "[illegible] if you go to your wit, and what Mr. Cranbourne says, I cannot attempt to talk to you about the barometer."

"Well, I will be very attentive," said Lucy. "Sup-

pose, then, I was at the bottom of a well. But should not I be drowned?" added she, in a low voice.

"Very true, I should not have said the bottom of a well, but the bottom of a deep pit," said Harry.

"Oh, that is another affair," said Lucy; "I like that better. Now, then, I am at the bottom of a deep pit."

"Now, then, which do you think would weigh the heaviest, the air at the bottom of this pit, or the air at the top of a high house?"

"I think it would weigh heaviest at the bottom of the pit," said Lucy.

"Why?" asked Harry.

"Oh! my dear, such an easy question," said Lucy.

"Well, answer it, at any rate," said Harry.

"Because, in the bottom of the pit, the air in the pit is added to the air that is above the pit, and also you must add all the air that reaches to the top of the house."

"I believe you understand it. Suppose you took this barometer to the bottom of the pit, do you think that the mercury would rise or fall? My dear Lucy, pray think before you answer."

Lucy thought, and answered, "I think it would rise at the bottom of the pit."

"Right; now, if you took it to the top of a high house, would it rise or fall?"

"I think it would fall," replied Lucy.

"Why?" said Harry.

"Because then there would be less weight pressing upon the quicksilver in the cup, and therefore less quicksilver would be pressed up into the tube."

"Very well indeed, Lucy; I see you remember all papa taught us about the barometer. Now suppose the pit was sixty feet deep, and that the house was forty feet high. Forty and sixty make a hundred, you know."

"To be sure," said Lucy. "Well!"

"Well," said Harry, "I must go slowly. Suppose that you observe exactly how much the quicksilver falls when you take it from the bottom of the pit to the top of the house, you would have a measure by which you could judge of the whole height and depth."

"I see I should," said Lucy; "I see! I see the use of your barometer, and it is very useful."

"But you do not see all yet," said Harry. "By marking this, you would not only know how much the quicksilver falls in that hundred feet, but by dividing it, and making a scale, you might know the same thing afterward, in any number of feet, in any height to which you might take the barometer; and by this you would have an easy way of measuring the height of mountains."

"Very ingenious! very convenient!" said Lucy. "Now I understand the use of your portable barometer perfectly."

"Not perfectly," said Harry. "There is a great deal more to be learned about heat at different heights, and rarefaction of the air. But I will not puzzle you with that, especially as I am not clear about it yet myself. But this is the general notion, which papa says is quite enough at first."

"Quite enough for me," said Lucy. "Thank you, Harry, for telling me no more."

"I wish! oh how I wish!" cried Harry, "that we had a mountain to measure with my portable barometer!"

"But," said Lucy, "a mountain will not come to you for wishing for it, any more than to Mahomet."

"Mahomet!" repeated Harry. "What do you mean?"

"Do not you know, Harry, the common saying, Since the mountain will not come to Mahomet, Mahomet must go to the mountain? You were by, Harry, when I read this in our Universal History to mamma, do not you remember it?"

"No, I forget it. How much better you, Lucy, remember some sorts of things than I do."

"And how much worse I understand other sorts of things than you do! therefore, as mamma says, we can help one another, and then in time we shall know twice as much between us. My dear Harry, how convenient that will be, and how happy we shall be."

"Very happy; but we cannot be always together," said Harry, "so we must learn to remember what we want for ourselves, or it will be rather inconvenient when we are separate."

"We shall not be separated for a great while," said

Lucy. "Papa said yesterday to mamma, I heard him, that you are not to go to school yet."

"I am very glad of that," said Harry, "for I shall be so happy going on at home, learning from my father, and with you, Lucy! But, my dear, to go back to Mahomet, for I do not like to let that go without in the least understanding what it means."

"Never mind; only a bit of wit," said Lucy.

"But cannot you explain it to me?" said Harry.

"No, it is so easy, that if you do not see it at first, I cannot make it plainer," said Lucy.

"Do try," said Harry.

"It means only that Mahomet was foolish for commanding the mountain, in a braggadocio way, to come to him; and when all the people standing by expected, perhaps, that the mountain should obey him, and come at his bidding, and when it did not stir, he came off in a shabby way by saying, that since the mountain did not come to him, he must go to the mountain."

"Is that all?" said Harry; "but you told me it was a common saying."

"Yes, afterward it came to be a common saying, whenever a person proposes something which seems fine and grand, and which they cannot really do, and when they come off with doing something common and easy, then comes the saying about Mahomet and the mountain."

"Thank you," said Harry, in a tone as if he had said, "Thank you for nothing."—"But still I do not understand how this applied to my wishing for a mountain to measure with my portable barometer."

"Oh! my dear Harry, do not be so grave about it," said Lucy.

"I only look grave, because I am trying to understand," said Harry, "how the story applied."

"I suppose it did not *apply*, as you call it," said Lucy, after considering for a few moments. "But do not let us talk any more of it."

"Only tell me how it came into your head!" said Harry.

"I cannot tell," said Lucy: "when you said something about wishing the mountain would come to you—"

"No, no," interrupted Harry, "that was not what I said exactly."

"Well, never mind *exactly*, about such a thing as this,

my dear Harry," said Lucy; "I only know that, whatever it was that you said, the sound of the words about mountain brought the mountain and Mahomet into my head."

"The sound of the words," said Harry; "so, after all, the words only came jingling into your head from the sound, and had nothing to do with the business; and I have been all this while trying to make sense of nonsense."

"I told you it was nonsense at first," said Lucy.

"You told me it was wit," said Harry.

"Well, my dear, if one tries to explain wit, it often turns into nonsense."

"Then what great good is there in wit?"

"If you understand it at first, it is very diverting that is good," said Lucy.

"But if I cannot understand it at first," said Harry.

"Why, then, I cannot help it," said Lucy.

"That is rather provoking," said Harry.

"More provoking for me," said Lucy, "this time. I have been trying and trying to explain; but, in explaining, the wit is lost, the pleasure at least is all gone."

"But that was not my fault," said Harry.

"Yes, but it was, my dear, for not understanding it at first."

"That is the same thing you said before, my dear Lucy."

"Because it is the truth, my dear, and I have nothing else to say, Harry."

"And I have only to make the same answer I made before, Lucy; that if I cannot understand it I cannot."

"And I come round again to 'I cannot help it, Harry.'"

"That is arguing in a circle, as papa says," observed Harry.

"I do not know what is meant by arguing in a circle," said Lucy; "I suppose it is something in Euclid."

"No, my dear, Euclid never argues *in* a circle; he only argues *about* a circle or circles."

"*In* and *about*," said Lucy; "oh, let us say no more about it. I hate saying so much about one thing."

"I like to stick to one thing till I understand it," said Harry.

"But when you can't!" said Lucy; "you really are so slow, Harry, about wit."

"Perhaps I am a little slow," said Harry; "but recollect, Lucy, that you acknowledged yourself, at last, that the story did not apply, so how could I understand it?"

"Well, I acknowledge," said Lucy; "but that excuse will only do for this once."

"I dare say I shall find another next time," said Harry. "But now look, Lucy, at those two men carrying that long ladder across the lawn. What are they going to do with it, I want to know?"

They were going to carry it to a church in the village, the steeple of which wanted some repair; his father followed the men, and Harry asked if Lucy and he might go with him. His father gave him leave, and Harry carried his portable barometer with him, saying that he thought he could try it at the top of the church.

In the church there were stairs which led up to the gallery, but there was no way of going up to the top of the tower but by means of a ladder. The men fixed it steadily, and Harry's father went up. Harry wanted to follow, but his father said he must not come yet, because he had not time to think of him till their business was finished.

"My dear Harry," said Lucy, "I think it is very dangerous; you will never be able to go to such a height. I am almost afraid to look at papa going up, it makes my head giddy."

And when his father called him, she held the flap of his coat, and said, "Indeed, Harry, you had better give it up."

"Give it up!" no, that he would not.

He began to run up the ladder with the barometer in his hand. But his father called to him, and bid him "stop," and ordered him to give the barometer to one of the masons, who was behind him, whom he requested to carry it for him, and to follow him up the ladder.

"Oh! papa, I am used, you know, to mounting ladders, and I am safe without anybody to take care of me."

"Do as you are desired, or you shall not come up at all," said his father.

Harry obeyed; and when he got high up on the ladder, he felt that his father was right; for though he had been used to go up ladders, he had never gone up one that was nearly so high. He felt an unusual sensation

of giddiness in his head. He was glad the man was close behind him, he held fast to the sides of the ladder, stepped up very carefully, and seized his father's hand, who was waiting for him at the top. When landed safely on the roof of the tower he looked about him: when he looked down his head still felt a little giddy, and it was some moments before he recovered himself sufficiently to think even of his portable barometer. Then he recollected that, in his hurry to come up, he had forgotten to mark how high the mercury stood when he was on the ground. He did not like the thoughts of immediately going down the ladder again. It occurred to him that it would do exactly as well to mark the height at which the quicksilver now stood at the top of the tower, and afterward to see how much it would rise when he got to the bottom; but Lucy had his pencil and paper below. He wrote the figures on a bit of slate which one of the men had in his hand. After being a little used to it he grew quite at ease at this height, and could think as well as when on the firm ground. When he was to go down the ladder he was a little startled by hearing Lucy cry out, "Oh, Harry, take care."

His father stopped him, told Lucy she was very foolish to call out, desired her to go into the church, and wait there till they should come; which she did, and very glad she was when she saw Harry and her father come down safely.

Upon examining the bit of slate on which he had written his figures, and which he had put into his bosom while he came down the ladder, he found that they were so rubbed that it was impossible to make them out. Lucy, who was afraid of his going up again, was by turns sure that one figure was an eight, a nine, or a naught.

This would not do for Harry, he must go up again. His father said he was right; and this time he wrote down what the barometer was before he went up, and carried paper and pencil with him. His father was so good as to accompany him. It was all done rightly, and this time Lucy did not say a word till Harry's foot was off the last rung of the ladder, and safe on the ground.

Now they knew exactly how much the quicksilver had fallen in going up to the top of the tower, and at

what it had stood at the bottom. Harry said that this must be compared with a table of measures which he had at home, which would tell the height in feet and inches.

And here be it noted, that on this and many other occasions, Lucy's readiness in arithmetic was of use to her brother when he came to his calculations. The habit of writing her figures exactly underneath each other, in the right rows, and of drawing straight lines and making neat little figures, all proved of advantage when she was called upon to write down totals for him in a great hurry, or to go over and copy clearly his scrawled sums in addition, multiplication, subtraction, and division.

On the present occasion difficulties occurred, and Lucy sat beside Harry for a quarter of an hour, writing down and rubbing out figures upon a slate, and complying by turns with contrary orders.

"Lucy, my dear, write down 452, and subtract it from 930—have you done it?"

"Stay a bit—presently—yes."

"My dear, I meant to say *add*, did I say subtract?—no, add, add."

"Well, I have added."

"Now multiply that by—no, stay—first it must be divided—stop—I do not understand this table: there is something about height above the level of the sea here that I cannot make out. Then what is this *about expansion*," continued he, reading. "Oh, my dear Lucy, we are all wrong. I do not know how to allow for the thermometer; and here is a calculation about expansion and proportion, and heaven knows what. Oh! it is all wrong—I do not know what I am about."

This Lucy had suspected, but she had the good-nature not to say so; and as all she had done was right, she found it easy to be patient. Harry ran to look for the article *portable barometer*; no, *barometer, portable*, in a Cyclopædia; but there opened to Harry's eyes such a quarto scene of tables, and fractions, and algebraic signs, as quite dismayed him, and Lucy stood in stupified silence beside him. At length he observed,

"There is a great difference between having a general notion of any thing and knowing it thoroughly. I thought I understood the use of this barometer perfectly; but, when I come to try, I cannot make it out well."

"It is too difficult," said Lucy; "you will only puzzle yourself—" (she offered to shut the book).

"No, no, I will try and puzzle it out, and when papa comes in he will help me, and show me my mistake."

When his father came in he did help Harry, and with his assistance and patience it was all made clear.

"But, after all," said Lucy, "though you have found out the height of the church, it was a difficult way of doing it, with all those calculations. Would not it have been easier to have measured it by letting down from the top a string and weight, a plumb-line, as it is called, I believe; then you could have measured the string, and you would have had no difficulty."

"Very true," said Harry; "that would have been the easiest way in this instance, because we could get to the top of the church at once, and let down a plumb-line; but consider, Lucy, when we want to measure high crooked mountains, miles high, with ins and outs, and ups and downs, how difficult that would be. Besides, this puzzle with the portable barometer would not plague me again; it was only because it was my first time of trial, and I am glad that we have conquered the difficulty."

"It is very good of you to say so, for I did nothing but write down the figures and do the sums," said Lucy.

"But that helped me very much, and thank you for doing it so patiently. You did not yawn above six times. And now, my dear Lucy, if we had but a mountain to measure!"

"How happy we should be going to the top of it together, at any rate," said Lucy.

"Lucy, your hair is hanging into your eyes this morning," said her mother.

"Yes, mother," said Lucy, "because it is quite out of curl."

"Did you curl it last night, Lucy?" said her mother.

"Yes, mamma, I did indeed; and it curled very nicely this morning early; but I went out in hopes of meeting my uncle, who was to have come to breakfast; and by the time that I came in again my hair was all as you see. The breakfast-bell rang, and I had not time to curl it again."

Her mother was satisfied, since Lucy had not neglected to curl it at night, which had sometimes been the case. Her father asked if she knew what had uncurled her hair when she went out.

"The damp of the morning, papa," said she: "*my* hair always goes out of curl in damp weather."

"So does mine, Lucy," said her mother. "It is not peculiar to your hair to go out of curl in damp weather."

"But, Lucy, what do you mean by your hair going out of curl?" said her father.

"Just what you see, papa; that it hangs straight."

"You told me the moisture of the morning uncurled it; do you know how or why it does so?" said her father.

"No, papa, not in the least; I wish you would tell me."

"When your hair is curled, the parts of one side of each hair are pressed close together, and the parts on the other side are stretched out. Give me that piece of packthread."

It was loosely twisted. He coiled up a bit of it, and showed her, that in the inner circle the parts are pressed together, and in the outer they are stretched.

"Now I see," said Lucy; "and you mean that it is just the same with my hair when I curl it. But still I do not understand how the damp straightens it."

"That you shall see directly," said her father; and he dipped the curled packthread into a cup of water; when it was all wet it became straight.

"Yes, it has uncurled, like my hair," said Lucy. "But how?"

"Look, and you will see that the water has filled all the interstices, or vacancies, which you observed between the different parts of the cord. Now there are in your hair, and in all hair, pores, or small vacancies, which can be filled with moisture, like the interstices in this packthread, and which imbibe moisture from the air, as this packthread imbibed the water, and you see it filled the pores on the inside as well as on the outside."

"Thank you, papa," said Lucy, "that is very nice. To know why my hair uncurls is at least a comfort. Now I understand it all."

"Not all," said her father. "There is a property of

hair which you do not yet know; that when it is wet, that is, when its pores are filled with moisture—"

"I see, papa; you mean it swells out, and becomes thicker, like this cord."

"Not exactly like that cord, Lucy; that cord shortens as it swells out in breadth; but hair lengthens when it is moist. All human hair is easily affected by moisture."

"Very easily, indeed," said Lucy, dividing her uncurled locks on her forehead, and trying to put them out of her way. "I was *not* in the damp above ten minutes, and yet you see how straight my hair has become. Indeed, papa, as you say, human hair is very easily affected by moisture."

"Yes, fortunately," said Harry.

"Fortunately!" repeated Lucy; "unfortunately, you mean. Why do you say fortunately?"

"I have a reason, and a good one," said Harry. "It is fortunate that hair has that property. For one reason, for one purpose, useful to all men and women, but especially to men of science."

"Fortunate and useful!" said Lucy. "Brother, how can it possibly be fortunate or useful to you, or to men of science in particular, or to anybody, that my hair should so easily go out of curl in damp weather?"

"Not your hair in particular, Lucy, but hair in general," said Harry.

"What use," said Lucy, "if everybody's hair in the whole world was to go out of curl like this every damp day—what use could it be but to make them all look very deplorable, as mamma says I do when my hair is in this condition? What good would this do to men of science, or any men?"

"You do not understand me," said Harry, smiling. "Did you never hear of an hygrometer?"

"Hygrometer!" said Lucy, "Yes, I have often heard of an hygrometer. I heard papa talking to you about hygrometers very lately, and reading a great deal last Wednesday—no, last Thursday."

"No matter, my dear," interrupted her father, "what day you heard me reading about it: do you know or do you not know what an hygrometer is?"

Lucy confessed she did not know *exactly* what it was; but she thought it had something to do with a barometer and a thermometer, because it ends in *meter;* and she remembered long ago her father had told her that

meter meant *measure*, and comes from some Greek word that means to measure; therefore, she supposed an hygrometer must be a machine or an instrument for measuring something, but what she did not know; she guessed it was something about the air.

Her father said that she was so far right in thinking that it is an instrument used to measure something. He told her that it measures moisture in the air; and that the name hygrometer is composed of two Greek words, hugros, *moist*, or moisture, and metron, *measure*.

Lucy liked this name, which contains, as she observed, the history of the thing; and now she knew this, she thought she never could forget it.

Their uncle had not yet come in to breakfast, and their father beginning to read the newspaper to their mother, Harry and Lucy went on, at the farther end of the room, talking to each other.

"Now you can guess," said Harry, "why I said that it was very lucky that your hair uncurls so easily in the damp. You observed yourself that you could always know by your hair whether it is a damp day or not, whether air is moist or not."

"So hair is an hygrometer," said Lucy, "for it measures moisture. I am sure my hair might say, if it could speak Greek, *hygrometer;* or, in plain English, *moist—I measure.*"

"Very true," said Harry; "but still you do not know the measure exactly *of how* moist, how damp the day may be; do you?"

"Yes, on very, very damp days, my hair comes quite out of curl, as you see it now," said Lucy, "and hangs quite straight; but it only comes a little out of curl on days that are a little damp or damp-ish."

"A little damp! 'Damp-ish!'" repeated Harry; "that is very well for common talking, but it does not describe exactly how damp. I do not know what degree of moisture you mean to express by damp-*ish*."

"Pish!" echoed Lucy. Harry would not smile.

"You have not yet told me, Lucy," said he, gravely, "how the hygrometer is made to show the measure of moisture exactly."

"I do not know *exactly*, brother. But suppose, for instance, you knew how long my hair is when it is quite dry; then, in damp weather, when it is moist, and hangs

straight, you could measure how long it has grown; I mean, how much it has lengthened by the damp."

"I could measure," said Harry, "but how?"

"You could see whether my hair comes down as far as to my eyebrows, or only this far, or this far," said Lucy, touching different points on her forehead. "If I had a looking-glass, I would measure this for myself."

"This might do," said Harry; "but at best it would do only for yourself, and but badly for yourself, because you must, to mark your points, have disagreeable spots on your forehead always."

"I should not like that," said Lucy, "nor would mamma, I am sure."

"Besides," continued Harry, "it would be rather inconvenient to me to run in search of you, with a pair of compasses and my ruler, to measure your hair and your scale on your forehead. This would be rather an inconvenient hygrometer."

"Rather, I acknowledge," said Lucy; "you would twitch all the hair off my head too, in measuring each hair, I suppose; and I should be afraid that you would put out my eyes with the points of your compasses, when you came to measure the scale on my forehead. I should not like to be your hygrometer."

"I would much rather have one that would always stand or hang in my room," said Harry; "or one that I could carry about in my pocket, better still! Could you manage that for me? Could you find out how to do that? I found out how to do it."

"Did you indeed, brother! and do you think I can?"

"Yes, if you think well, and if you go on thinking," said Harry.

"I will then. But tell me exactly what I am to think about, and what is to be done," said Lucy.

Harry pulled a hair out of his own head, and laid it on a piece of white paper before her. "There," said he, stretching it out, "you see its length. We will suppose this hair is as dry as it can be. Now I will dip it into this basin of water. Now that it has been wet, it is longer than it was when it was dry."

"Yes; but we want to know how much longer," said Lucy. "Well, it is easy to lay it on this sheet of paper, and measure, as exactly as you please, how much longer it is when it is wet than it was when it was quite dry."

"Very well," said Harry, "and I can tell you that you would find it to be one fortieth of its length longer. Then you have the utmost length between extreme moisture and extreme dryness."

"And," continued Lucy, "I could divide this line on the paper between the two black dots, by which you marked the points to which it stretched when it was dry and when it was damp; and, if divided exactly, it would be what you call a scale; you could measure how much, in different degrees of damp or dry, it stretches or shortens."

"Very well, indeed," said Harry; "and the scale on paper would be better than on your forehead, you see. That's one point fixed."

"That's one point gained," said Lucy. "Now what is to be done next?"

"Next, you are to find out how, without the trouble of continually plucking hairs out of my head or yours, and wetting or drying, and measuring them, you might know every day or hour, or at any time you please, how damp the air is, or how much moisture it contains."

"If I could but make the hair measure itself," said Lucy, "and mark or show how far it shrinks or lengthens on this paper in any time."

"Ay, if you could," said Harry, "that is the question."

"Suppose I had a very, very, very little weight," said Lucy, "so little, that this hair could support it without breaking; then I could tie it to one end of the hair, and hang the hair by the other end to something, suppose a piece of wire stuck into the wall: and I would put this paper, with our scale upon it, against the wall, just behind the weight, and when you look at it, you would see how much the hair had shrunk or lengthened, at any time, in damp or dry."

"There, papa!" cried Harry; "Lucy has made out as far as I did the first time I thought of making an hygrometer!"

Lucy looked much pleased with herself, and with her brother for being pleased with her.

"And have I really invented an hygrometer, Harry?" cried she.

"Yes, but not a perfect one, my dear," said Harry; "there is a great deal more to be done."

"What more?" said Lucy.

"To come to breakfast, in the first place," said her father.

This Lucy was ready to do, for she was a little tired; but by the time she had refreshed herself by eating half her breakfast, she returned to the question—"What more is to be done, brother, about the hygrometer?"

"To make it more convenient," said Harry. "In your way, it must always be stuck up against a wall; and besides, your divisions are so very, very small, that you can hardly see how much the hair lengthens or shortens."

"You might take a magnifying-glass," said Lucy.

"Well, that would help; but cannot you think of another way?"

Lucy thought for a little while, and went on eating her breakfast, and presently answered, "No, brother; I can think only of taking a larger magnifying-glass, a glass that magnifies more. Will that do?"

"Still there is an easier method; put the magnifying-glass out of your head."

"It must be a more difficult, instead of an easier way, for I cannot find it out," said Lucy.

"But it is easier, I assure you, when you have found it out," said Harry. "Come, I will help you a little," continued he, after she had considered for some time. "Look at the hand of that clock," and he pointed to the dial-plate of a pendule which was on the chimney-piece opposite to the breakfast-table. "Look, the hand now points at ten. Do you see how far it is from ten to eleven? Suppose that hand was to move from ten to eleven?"

"Well, suppose," said Lucy, "I can easily suppose this."

"Then which would have moved the farthest? which would have gone over the most space? the point of the hand which is at the outside of the dial-plate, or that part of the hand which is closest to the centre?"

"The point of the hand which is at the *outermost* part of the circle would have gone the farthest; I mean, would have moved over the most space. The part nearest to the centre would have moved so little, that I suppose I should hardly be able to see or measure by my eye how much."

"True," said Harry, "you could not; but you could see and you could measure the space from ten to eleven easily; could not you?"

"Certainly," said Lucy.

"You could guess the measure even by your eye, without taking compasses or magnifying-glass," said Harry.

"Now I see what you are about," said Lucy; "I must have a little, *little* hand, and dial-plate, for my hygrometer, to show and to measure the least motion of the hair in shortening or lengthening."

"Right," said Harry; "so far right."

"Do not tell me any more," said Lucy; "I can do it all for myself now, and in a minute."

"Do not be in such a hurry, my dear," said Harry, "or you will never do it."

"Hurry! I am not in the least hurry," said Lucy, "only I like to be quick. Well, I would fasten the end of the hair to the axle, so as to make every, the smallest motion of the hair, move the hand."

She paused. She was not quite clear of the manner in which this was to be done.

"I will help you," said Harry. "Suppose—"

"Suppose," said his mother, "that you were to let Lucy finish her breakfast."

"I will and welcome," said Harry; "for now she has the principle of an hygrometer, which papa was explaining to me the other day, and of which I will show her a plate after breakfast—"

"A plate!" said Lucy; "I may as well have the plate at breakfast, may not I?"

"By a plate I mean an engraving," said Harry; "did not you know that?"

"Oh! yes, to be sure," said Lucy; "I was only in play."

Breakfast finished, Harry went to the library to look for the book, and Lucy followed, eager to see the drawing and description of what she had been trying to invent. He showed her in Rees's Cyclopædia two engravings of different hygrometers.

"This," said he, pointing to one, "was invented by a great English engineer, of the name of Smeaton; and this other by Monsieur de Saussure, the famous Swiss traveller. Yours, Lucy, my dear, is not exactly either of these; it is most like Smeaton's, but he uses a cord,

with a weight hung to it, instead of a hair. It is said, however, that a hair is better than a cord for our purpose."

"And how does the other man, M. de Saussure, manage with the hair?" said Lucy.

Harry pointed to the engraving, and showed her that one end of the hair is fastened, as she had proposed, to the axle of the hand, and the hair wound round the axle; but the other end, instead of having a weight hung to it, is strained tight, and fastened to a frame of wood below. Then, when the hair shortens or lengthens, with dryness or moisture, it turns the axle of the hand a little or much, according to the shortening of the hair.

"Turns the axle of the hand!" repeated Lucy. "I see it would turn when the hair shortens, because that would pull it round; but I do not see how, when the hair lengthens, that it would turn back the axle and the hand. I think that the hair would only loosen round the axle."

"True, Lucy, and accurate," cried Harry, with pleasure in his eyes; "but look again at this engraving. See here a weight hanging to this little cord, which is wound round the axle in a contrary direction to the hair. The weight is just enough to keep the hair constantly strained, so as to prevent it from loosening, as you rightly said it would, round the axle, if there was not any thing to prevent it when the hair lengthens from moisture. Then, as it is kept stretched, it turns the axle and hand."

"Yes, now I see no difficulty," said Lucy. "I understand it quite; and I am glad I told you the difficulty, for you have cleared it away. I hate to feel that I have only half understood, and to leave off in a puzzle. But, Harry, here are prints of a great many more hygrometers."

"Yes, made of different substances," said Harry; "many things beside hair, you know, can be used to show the changes of moisture and dryness; all things which show these easily. Some of them we have observed ourselves often."

"Oh! yes," said Lucy; "salt and sugar, for instance, and some kinds of wood, which *warp* with the changes of the weather from wet to dry. The wood of this window-frame, I remember, was swelled so much during the rain last week, that we could not open the sash."

"Yes, that sash is made of deal, the wood of fir-tree,

you know," said Harry; "and this sort of wood shrinks and expands quickly with dryness and moisture."

"I recollect," interrupted Lucy, "I read something about a creeping wooden hygrometer, in the notes to the Botanic Garden. My dear, I remember it perfectly, because it was entertaining. There was a wooden automaton, a machine that moved of itself—"

"I know of no such machine," interrupted Harry, "If it moved, it must have been moved by some cause."

"Well, the damp, I suppose, was the cause. Now let me go on, Harry. It was a wooden automaton, with a long back, and four feet, with iron-pointed shoes, which clawed on little by little, so that it walked, or crept, or clawed, quite across the floor of its master's room in a month's time, from the changes of damp and dry. I do not know how, but it was very entertaining, and it will entertain me now much more if you can show me how it was contrived. There was, I remember, something about gluing the bits of wood that made the back, I do not rightly know how," said Lucy, "crosswise."

"Cross-grain, I suppose you mean," said Harry. "We will look for it by-and-by, and I will try if I can understand and explain it to you. But now go on, and guess some other substances of which hygrometers are made."

"I do not recollect any more; help me a little," said Lucy.

Harry pointed to his mother's harp.

"I see mamma's harp," said Lucy, "but that only puts me in mind of the last tune she played."

"Do you not recollect that a string broke yesterday?"

"Yes, I do, and how troublesome it was!" said Lucy. "I remember that Mrs. ——"

"Stay, now, do not go to Mrs. Anybody, but think of the cause of that string breaking."

"Mamma said that it was cracked by the sudden change of the weather."

"What change?"

"From dry to damp, I believe," said Lucy. "Oh, now I understand it, and I know what you mean. In damp weather the moisture from the air gets into the strings, and swells them out, and so shortens them that, if they are held tight at each end, they crack. Those strings are made of catgut. Catgut, then, would be a good thing for an hygrometer."

"Yes," said Harry; "but now I will tell you another thing used for hygrometers, which I do not think you could guess—ivory."

"Ivory! no, I never should have thought of that," said Lucy. "I never knew that ivory lengthens and shortens in damp or dry weather."

"It does though," said Harry; "there are a great many pores in ivory; we cannot see them without a magnifying-glass, but the moisture gets into these pores and swells it out. But now, Lucy, there is another common thing, which you see every day, which you might guess. When you dip it in water, you may see its great pores swelling without any magnifying-glass; and then, when you squeeze the water out and dry it, it shrinks so that you could hold in your shut hand what, when full of water, was as large as my head."

"A sponge! a sponge!" cried Lucy. "But if a sponge is left in a room by itself, would it suck up water from the air?"

"Yes, whether it is left in a room by itself or not," said Harry, "it will absorb (do not say *suck up*) moisture from the air; and it grows heavier when it is filling with moisture, or lighter as it dries. The sponge hygrometer is measured, or measures, by weight, not by lengthening or shortening, expanding or contracting. You do not look as if you understand this, Lucy."

"I do," said Lucy, "but I am growing tired. I think I have had enough about hygrometers."

"No, no, you cannot be tired so soon; guess once more," said Harry; "you may easily guess this, because it is a thing used in your dress."

Lucy had observed, she said, that her gloves often grew damp in wet weather. She guessed leather. It was not what Harry meant; but he said that he thought leather would do, and he did not know why it had not been used; perhaps, as it takes in moisture so easily, it may not expand or contract equally.

Encouraged by Harry's approbation of her good guess of leather, Lucy was willing to try and guess again. "But help me," said she.

Harry told her that the thing he meant is stiff, and yet not so stiff but that it can be bent; it is springy and elastic.

She thought of several things which can be bent, but she could not guess right; and then, yawning and

stretching herself, she repeated that she was tired, and that she could not guess any more; Harry must tell her.

"Then I will tell you—whalebone, my dear. Come, have done yawning," said Harry; "I will not make you guess any more; and now I will show you something entertaining; I will show you a nice little hygrometer, made of an Arabian oat's beard."

"Show it me," said Lucy, stopping in the midst of a full stretch.

"Here, in this print," said Harry.

"Only a print! I thought you had the real beard," said Lucy.

"You might make an hygrometer yourself, I dare say, of a common English oat beard," said Harry.

"Well, that I should like," said Lucy; "you were right after all, Harry, when you said it was lucky that my hair uncurled so easily. How odd it is, Harry, that I have been carrying all my life on my head, without ever thinking of it till this morning, one of the best of hygrometers! My having an hygrometer without knowing it, is like the man who talked prose all his life without knowing it."

"I do not know what man you mean," said Harry; "come, now, look at it, this Arabian oat hygrometer, Lucy; it is the great Doctor Hooke's."

"I do not care about the great Doctor Hooke," said Lucy; "but let me tell you about the man who talked prose without knowing it. He was a man in a play, a very entertaining play papa was reading one evening when you were not listening. There was a maid-servant teaching her old master his letters, and asking him what he does when he says the letter *u*. Now you shall be the old man, and I will be the maid, and I will teach you. Say *u*."

"Nonsense, my dear," said Harry.

"Not at all nonsense," said Lucy; "you may ask papa."

"Well, but I have not time now," said Harry.

"And the maid taught him to fence," continued Lucy; "if I had but a stick I would show you."

"Now your head is gone quite off to the play. I shall have no more good of you," said Harry, looking mournfully. "But here comes my uncle," continued he, as his uncle at this moment entered the room. "Uncle, will you look at this hygrometer for me?"

"I will, Harry, with pleasure," said his obliging uncle.

"And so will I, Harry," said Lucy, "to oblige you. My head is come back from the play now."

For about three minutes she was attentive, and she understood and admired, to Harry's heart's content, the Arabian oat hygrometer.

"Then, now, Lucy, I will show you a much better," cried Harry; "one which is made of a kind of Indian grass, which grass is extremely sensible."

"Extremely *sensible* grass!" interrupted Lucy, laughing. "Uncle, I never heard of extremely sensible grass before! Did you?"

"I think *you* are not extremely sensible now, my little niece," said her uncle, "to begin punning, instead of minding what your brother is telling you. Surely you know that sensible means sensitive, that is, having quick or great sensibility. You know these words are applied to plants, for you have heard of the sensitive plant."

"Oh! yes, to be sure, uncle," said Lucy; "I was only playing. I know the two meanings of the word sensible as well as anybody; and I have not only heard of the sensitive plant, but seen it, at aunt Pierrepoint's; and not only seen it, and its leaves closing up, and shrinking back from my touch, but what is more, uncle, I have learned by heart Dr. Darwin's lines on the sensitive plant, the Mimosa."

She repeated them, and her uncle said that they were pretty lines, and that she repeated them well.

"And would not they make a good motto for an hygrometer, uncle?" said she.

"Very good," said her uncle.

"And now," resumed Harry, "let me show you this hygrometer."

"One other motto, my dear uncle, I have thought of for the barometer," continued Lucy: without considering how much she was trying her brother's patience, she went on repeating, while she held her uncle by the flap of his coat,—

"'You charmed, indulgent sylphs, their learned toil,
And crowned with fame your Torricel and Boyle.'"

"*Torricel!*" cried Harry; "I suppose you mean Torricelli."

"No, it is Torricel in the lines, I assure you," said Lucy.

"It is Torricelli out of the lines, I assure you," said Harry. "There never was such a man as Torricel, was there, uncle?"

Their uncle whispered to Lucy that Harry was right.

"Well, never mind, it must be Torricel here, for the sake of the line," said Lucy, "else it would be too long. Let me go on; I will tell you what the indulgent sylphs taught these people." She went on repeating.

"Beautiful lines, Lucy," said her uncle; "but I am sure you cannot understand them, as you are not yet acquainted with the airpump."

"But Harry is," said Lucy, "and he will explain it to me; will not you, Harry?"

Harry looked very serious, sighed, and said nothing.

"Why do you sigh, Harry?"

"Because," said her uncle, "he is afraid that he shall never be able to make you understand the airpump, or any thing else, if you are not more attentive."

"Harry, I beg your pardon," said Lucy. "But you know I was very attentive at first."

"And will be very attentive at last, I hope," said her uncle. "Come, we will both be serious," added he, sitting down at the table; and drawing Lucy towards him, he seated her on half his chair, put one arm round her, and leaned his other on the table, in an attitude of attention. "Now, Harry, explain your hygrometer, and spare the remains of that poor pen."

"But Lucy looks tired," said Harry. "Have you a mind to see the hygrometer or not?"

"I have a *little* mind," said Lucy; "that is, I have a *great* mind to please you, brother, only we need not go through them all," said she, as he placed the plates before her.

"No, do not be frightened," said Harry, "I am not going to show them all to you; I am going to show you only the very best."

"Stay," said his uncle, putting his hand over the engraving to which Harry was pointing. "Do not show her that, show her any other, she must not yet see that."

"Why not? I wonder why!" said Lucy.

"I have a reason," said her uncle. "But never mind or think about that which I hide under my hand, my

dear; attend to what your brother is going to show you."

"Which shall I show her, uncle?" said Harry; "shall I show her De Luc's ivory or whalebone hygrometer?"

"The whalebone, for that is the most simple, I think," replied his uncle.

Harry, with the article Hygrometer before him, began:—

"Look here, Lucy, do you see little *a* and little *b*; this represents a small thin bit of whalebone, cut across the grain; you know what is meant by the *grain* of the whalebone; but do you see little *a* and little *b*?"

No; Lucy, instead of looking at little *a*, *b*, was peeping at the back of the page, and reading something about a little man, and a little woman, and a weather-glass.

"Here is something very entertaining, brother," said she, "I must read it to you.

"In the Dutch toys called weather-glasses, one end of the index supports a small image of a man, and the other of a woman. The former appears, or is brought out, in bad weather; the latter in fair weather."

"I remember," said Lucy, "that once, at our widow Green's farm, I saw a weather-glass of this sort; but I was not then wise enough to know that it was called an hygrometer."

"There is no great wisdom in knowing that *name*," said her uncle.

"I wish you would show me how to make this thing, brother," said Lucy; "that would be something indeed."

"I can," answered Harry, "and I will another day, Lucy; but I can show you but one thing at a time. Now pray mind what you are about, because I have other things to do."

"Yes, Lucy, consider your brother's time," said her uncle; "he wants to go to his own affairs; pray mind what you are about."

"I will, I will indeed, uncle; I will Harry," cried Lucy.

Harry began again with,

"Little *b* is a thin piece of whalebone, cut across the grain." He was going on with his explanation, and went through *c*, *d*, and *e*, confident that Lucy was following him; but by that time he heard the sound of an ill-suppressed laugh, and, looking up, he saw Lucy with both

Lucy set down her basket of strawberries at the farthest end of the room, lest the smell should disturb her, and Harry took down and opened his large volume. But their hands were in no condition to touch delicate engravings: his were brown with garden mould, and hers pink with the juice of strawberries. The dressing-bell had rung, and their mother strongly advised their dressing before they began to read.

This advice, *to dress first, and then you are ready to do whatever you please afterward*, so often given by age to youth, and so seldom taken, or well taken, was in this instance acted upon instantly, without one murmur of the tongue, or one writhing of the body.

In all the self-complacency and safety of being ready half an hour before dinner-time, they met again in the library, where they found their uncle.

"Oh! uncle, I am glad you are here," cried Lucy: and after presenting to him their strawberries, they went to their book.

Harry asked whether he should go on with *old whalebone* or not?

"Go on with old whalebone," said his uncle. "Lucy should not leave that without understanding it: not that it signifies whether she understands that particular thing or not, but this will be a trial of her attention."

"I will be very attentive," said Lucy. But observing that her uncle placed his arm, as before, so as to cover one of the hygrometers in the engraving, her curiosity a little disturbed her. Her uncle remarking the turn of her eye, said,

"I advise you, Lucy, to repress your curiosity. Do not think of what is under my elbow, but of what your brother is showing you."

Lucy repressed her curiosity, and commanded her attention. Harry explained slowly, and she followed step by step patiently, undisturbed by the fear of being too slow, or the hope of showing that she was very quick; and without one glance at her uncle's arm, or one thought of what might be his reason for keeping it in that position, she went regularly through the *a*, *b*, *c*, *d*, of De Luc's whalebone hygrometer, and understood it, to her own and to her brother's complete satisfaction. Her uncle was, as he said, glad to perceive that Lucy had so far kept her resolution; and he told her that if she steadily went on in the same manner, she would

find it in time easy to do what she now felt so difficult, to fix her attention.

"And now," said he, removing his arm from the print, "you shall know my reason for covering this, and I will show you what I went home for."

He took from his pocket, and placed between Harry and Lucy, a small cylindrical case of about three inches high, covered with morocco leather.

"It is like the case of mamma's opera-glass," cried Lucy. "Is there an opera-glass in it?"

"No;" Harry smiled, for he knew what was in it immediately: he knew that it was his favourite hygrometer. His uncle took it out of the case, and placed it beside the engraving which he had covered with his arm, telling Lucy that he had wished only to delay showing her the engraving till she could compare it with the original, which he had walked home to bring for them. It was so simple, that, upon looking at it, and examining the plate, Lucy understood it directly. It is composed of a kind of Indian grass, which, like the beard of the Arabian and the English oat, twists and untwists with dryness or moisture, but in a much greater degree, making, it is said, from ten to sixteen revolutions from the extreme of moisture to the extreme of dryness. Harry told Lucy that in the description which he had read of this hygrometer, it is said that it shows more easily and quickly than any other the changes of moisture in the atmosphere.

"It is so sensible," continued Harry, "as to be affected by the shutting and opening of a door or window, and is sure to feel the approach of any person, and to indicate it by the motion of its hands."

"Let us try now if it will indicate my approach," said Lucy.

As she approached, the hands began to move; and when, as her brother bid her, she took it up and held it nearer to her, the motion increased; and when, as he desired, she breathed through the holes of the sides, one hand, affected by her breath, seemed to fly round the circle, while the other numbered the revolutions. Lucy was pleased full as much even as her brother could expect. She stood watching its quick variations as she breathed upon it or withdrew her breath.

"But, brother," said she, "did not you tell me that this has been but lately invented. How comes that?

Why did not people think of it before? Was not the grass always there, wherever this was found—in India?"

"I suppose it was," said Harry; "but nobody had observed it. All I know about it is, that in Rees's Cyclopædia, it says that this kind of grass was discovered in India about the year 1800, I think, was not it, uncle? by Captain Kater, who was employed in making some survey, or some observations, and who wanted a very accurate hygrometer to measure the smallest quantities of moisture; and he tried this grass, and found it succeed, and found that it lasts better and is more sensible than the English oat."

"Accurately remembered, Harry," said his uncle; "but pray, does the Cyclopædia tell you how it happened that Captain Kater took notice of this grass?"

"No, uncle," said Harry; "how was it?"

"He told a friend of mine that one evening, as he was walking without boots in that grass, he was annoyed by its frequent catching in his stockings; and when he took them off at night, he found them full of this grass, which had twisted itself into them. When he pulled it out, he observed it particularly. Then his attention being fixed, he remarked the sensibility of this grass to moisture, and he thought of using it for his scientific purposes as an hygrometer."

"How very lucky that it plagued him that day," said Lucy, "by sticking in his stockings."

"How well it was that he observed its properties when he took it out," said Harry, "and that he thought of applying it to some good use. I am afraid I should have thrown it away without observing it: at night, particularly, I might have been sleepy and tired; and then, uncle, the world would never have had this nice little convenient instrument."

"Would you, Harry, and would you, Lucy," said their uncle, "like to have this nice little convenient instrument for your own?"

Their eyes brightening with pleasure, they answered that they should like it very much.

"Then it is yours, my dears," said their uncle. "I give it you in the hope that it will teach you accuracy and patience."

They said that they would try to keep a register of it regularly; but Lucy added, that if it was only to teach her patience, she should not like it so well as if she

thought it would be also of some use to her uncle, or for some other purpose.

Her uncle assured her that it would be useful to him; he said that he had two friends, one living in Ireland, the other in America; they wished to keep a register of the dampness or dryness of the atmosphere in those countries, to be compared with England.

"Then," cried Lucy, "we will keep the register for England with pleasure: that will be something grand, and worth while."

"But," said her uncle, "if you attempt this, it must be done with accuracy, or it will be of no use. Remember, I tell you, it will be a trial of your patience. Do not begin it unless you think you can keep it regularly for six months."

"Half a year!" said Lucy, "that is a very long time." Harry, however, was not afraid to undertake it; because he had tried and had kept a register of a barometer for a whole year. He said his register was not neat, though it was accurate; his figures were too large, and straggling often out of their proper columns; but now he could use Lucy as his secretary, and she could make nice even figures.

Their uncle wrote for them some necessary directions. He said that it would be requisite to do, every time they registered their hygrometer, a sum in division of a certain large number of figures. This did not alarm Lucy, for she was expert in division, and she rejoiced that she should be able to do this sum readily for her brother; and that she should be wanted and useful every day, or maybe twice a day. They were eager to show their hygrometer to their father; but he had gone from home for a few days.

It was settled, that the first thing they should do every morning of their lives must be to examine and write down their hygrometer registry. Harry was always to *read off*, and Lucy to write down.

Whoever has tried to keep a daily registry, or to do any thing regularly every day, and at a certain hour, must know that it is not a very easy task; and where two persons are concerned, the difficulty is more than doubled, with the chances of one or the other failing in punctuality, and quarrelling about whose fault it might be. Harry and Lucy, therefore, by the experienced and the candid, will be allowed some credit for keeping their

register accurately every day for a month, without having complained of each other. Lucy repeated that she was very glad it was to be of some great use to her uncle at the end of the time; for that, without this motive, and the pleasure of helping her brother, and of making nice figures for him, she confessed that she could not have patience to go on with it.

"Thank you again and again, mamma, for allowing me to learn with Harry as I used to do. I am much happier already. But, mamma, if I knew ever so much, if Harry was not fond of me, and I of him, we could not be really happy. Could we, do you think, mamma?"

"In truth, my dear child, I do not think you could," said her mother.

"I am sure, quite sure we could not," continued Lucy. "Suppose I knew all the histories, and all the poems, and all the stories in the whole world, and that I could draw, and play on the piano-forte, and dance better than anybody in the universe, I am sure, mother, I could never be happy unless I loved my brother, and he loved me. Nor could he be happy, even if he knew all the 'Scientific Dialogues,' and all the mechanics, and hydrostatics, and optics—

"But, oh!" cried Lucy, interrupting herself in this enumeration of the *ics*, "there is papa come home! I could not think, mamma, what made you start up so quickly in the middle of my *optics*."

Lucy had too much discretion to produce their hygrometer the very moment her father came home; she waited till he had finished what he was saying to her mother; comprehending that this might be of more consequence to him, and more interesting, than even their new possession and their new arrangements. As soon, however, as he had leisure to attend to her, when he turned to Lucy, and holding out his hand to her, said, "Have you any thing new to tell me, my little girl?" She answered eagerly, "Yes, papa, a great deal!" He made room for her on one side of him, and for Harry on the other, and then they showed him their hygrometer; and Lucy told him how much she wished to understand what her brother had been learning the preceding years; and she told him of Harry's intention to

bring her up to him in science. She promising to go as slowly, and he as fast as he could, and to tire her as little as possible. Her father was glad that Harry had learned by his first attempt, that he should not, on any subject, tell all he knew to his sister at once, nor expect that she could at once take as great an interest as he did, on subjects of which she was ignorant; particularly when she had to endure all the labour and mortification which a beginner must go through, before learning any new science can be easy or entertaining. His father advised Harry not to attempt to describe all the small parts and detail of machines, nor to go over all the *a b c*'s of descriptions in engravings, which, however requisite for those who are to make them, would be unnecessary to Lucy. He advised Harry to try to give his sister a clear knowledge of the principles of some of the most useful inventions and discoveries. He promised to assist whenever he came to any difficulty, but he desired him to try first how he could go on by himself, in explaining to his sister. And he repeated to Lucy what her mother and uncle had said to her about attention. He told her that whenever he had attempted lately to teach her, he had observed that she did not attend as well as formerly.

"I know it, papa; I try all I can, but I cannot. I do not know how it is, I cannot," said Lucy; "every word that is said seems, as it were, to awaken some other words; and every thing I see and hear makes me recollect something else, and my thoughts are flying off backwards and forwards, and sidewise, and every way, while Harry's can go on straight forward, always thinking of what he is about, or of the very thing that is said to him. I used to be able to do the same," said Lucy, sighing.

"Sigh no more, Lucy," said her father, smiling. "No great harm is done. Your habits of attention have been spoiled, and your power of attending is consequently diminished; but with your own good-will and good sense we shall soon set all this to rights again. Your perceiving and reflecting upon what passes in your own mind, will assist you very much."

"Papa," said Lucy, "I know how it all happened. Aunt Pierrepoint did not think it signified much whether I attended strictly, as my uncle says, or not. She said I was quick enough. And I will tell you, papa, what

made a great impression upon me. Once I heard a gentleman talking about genius; and he said of me, that he wondered how I learned every thing with so little attention; that I was always looking about and listening to all that people said, and yet that I was so quick. I am ashamed, papa, to tell you any more," said Lucy, stopping.

"You have said quite enough, my dear little girl, to prove to me that you are not quite a goose. As long as any person is ashamed of being flattered, there is hope that they will learn to despise and dislike flattery. I give up only those who get over the pain of the shame, and who then like it shamelessly, and swallow down more and more of it, till at last they end by being fools to flattery, without knowing their wretched state."

"I hope I shall never be in that wretched state, mamma," said Lucy, with a look of much apprehension; "Harry, will you take care of me?"

"And of myself," said Harry.

"Well, now to business," said their father. "What do you wish to learn first, Lucy?"

She said that she wished to be made perfectly acquainted with the airpump, because Harry had reproached her with not having understood that fine poetic description of it which she had learned by heart and repeated. He said, that to be sure he could easily make her understand his uncle's airpump, because she already knew the principle of a common water-pump.

"Do I?" said Lucy, smiling; "I did not know that I knew it;" and here she again thought of the man who had talked prose all his life without knowing it; but she refrained from making an allusion to him, though it was ready on her lips. Harry recalled to her mind the experiments which their father had shown them two years ago.

"Do you remember," said he, "the experiment he showed us with a roll of tape, that was put under a wineglass, which was turned down, and plunged into a basin of water; and then the tape was pulled out, and unrolled by degrees?"

Lucy remembered all this.

"And what happened," said Harry, "when the tape was pulled from under the glass?"

Lucy answered, "That the water rose in the glass."

"And why?" said Harry.

"Because, when the tape was taken out, there was

left in its place a vacancy, a vacuum you call it; then the water which was in the basin rose into that vacant place."

"And why did it rise?" pursued Harry.

"Because it was pressed by the weight of the air, pressing on all the water in the basin, and it was forced up into the glass where there was no air, nothing to prevent or resist it."

"Very well; now I am satisfied," said Harry. "You remember it clearly."

"Because I understood it clearly at the time it was first shown to me," said Lucy; "my father was so patient, and explained it to me so slowly and clearly."

"Well," said Harry, "you have proved to me that you understand the first principle on which pumps are made, for all depends on making a vacuum, into which the water rises, or is raised. The first thing to be done is to make a vacuum. Now, Lucy, in a common pump, such as there is in the yard for pumping up water, *where* do you think the vacuum must be before the water can rise?"

Lucy said she supposed that it must be in the inside of the body or *tube* of the pump.

"Yes, we call it the *bore*," said Harry. "Now tell me how you would make a vacuum within it."

"Oh! my dear Harry, that is too difficult a question for me," said Lucy. "How can I tell how to make a vacuum in the *bore*, as you call it, of a great pump?"

"Where is the difficulty?" said Harry. "Do not be frightened by the word *bore*; or, if you are alarmed by the idea of a great pump, suppose a little one, as small as you please; as small, suppose, as the glass tube of the barometer."

"That would be easy to suppose; but could there be so small a pump?" said Lucy.

"To be sure, as well as of the largest size, only it would raise less water. But now go on straight forward, Lucy, my dear; do not ask me any of your starting-off questions. You must let me ask you questions, and you are to answer!"

"If I can," said Lucy.

"You can, I assure you, my dear," said Harry, in his most persuasive tone, "if you will only believe that you can, and keep steady. I ask you how you would make a vacuum in this tube?"

"Let me consider—let me recollect. What did my father do when he made a vacuum in the wine-glass?" said Lucy to herself. "He put in a roll of tape, which filled up the whole glass, and then drew it out, little by little, so as not to let any air into the glass while he was pulling it out again. But I cannot get a roll of tape into the small tube," said Lucy.

"No, not a roll of tape," said Harry; "but if you consider what was the purpose or use of putting the roll of tape into the glass, and drawing it out again, you will perceive that putting in and drawing out any thing else in the same manner would do as well."

"The purpose was, first, to force the air that was in the glass out of it," said Lucy, "and to prevent any more afterward from getting into the place which the tape took up, and which remained vacant as it was drawn out, leaving a vacuum at last."

"Now you are coming on very well, Lucy," said Harry.

"If I can put in any thing of any sort into the little tube, which forces the air out, and then if I could keep the air out, there would be a vacuum for you, Harry."

"Very well, you will now quite understand a pump, and you will soon know how to use it, Lucy."

"As to that," said Lucy, "I know how to pump already, only I am not strong enough."

"Stay! stay! Lucy; knowing how to pull a handle up and down, which I suppose is all you mean, is not understanding what I mean by knowing what pumping is, or how it is done."

"I have seen men and maids often pumping at the pump in the yard," said Lucy.

"What happens when they pump?" said Harry.

"The water comes out of the spout after they have pumped a little while," said Lucy.

"What do you mean by pumping?" persisted Harry.

"I cannot tell you exactly, Harry, because I never saw the inside of the pump. I only know that they move the handle up and down; and I believe there is something fastened to it, which I suppose brings up the water; but I do not know how exactly."

"I believe not indeed," said Harry; "then you see, Mrs. Quick-Quick, you did not understand what I meant by pumping. Now come with me, and I will show you in my room the nice glass pump which my father made for me. You cannot see into the inside of the pump in

the yard, but when once you have seen my glass pump you will understand the inside of all others."

He showed her in the first place a glass tube, in which there was a spout near the top. The tube was open at the top, and at the bottom there was a little door or valve, which opened upwards only: he poured water into this tube, to show her that the water would rest upon this valve, without its letting any of it through: he then emptied out the water. "Now," said he, "you know there is nothing but air in this tube. Look at this, which is called the piston of a pump." The piston was a cylinder, which fitted tight into the tube; at the top of it there was a valve like that at the bottom of the tube, which also opened one way, and that was upwards. Harry pushed it up several times with his finger, to show Lucy that it opened easily, and he made her feel that it did so. He then put the tube into a tub of water, the tube resting on two blocks of wood, which raised it from the bottom of the tub, so that there was room for the water to flow in through the lowest valve. Lucy, as he desired, held the glass tube upright, while he pushed down the piston, to which there was a long handle.

"Now, Lucy, what happens withinside of the tube?" said Harry.

"Nothing that I know of," said she, "but that you have pressed the air in the tube closer together."

"Very true; do you see the valve at the bottom? Is it shut or open?"

Lucy said it was shut.

"And what keeps it shut?"

"The air that you are pressing down upon it," said Lucy.

He pressed the piston down farther.

"Now look again," said he, "and tell me what happens."

"I see the little door at the top of the piston open," said she.

Harry asked her what she thought had opened it.

"The air," said she, "underneath it, which I suppose you could not compress any more, and which has forced its way up."

He now drew up the piston, and again asked what happened. Lucy saw the valve at the top of the piston shut, and she saw the water rush through the valve at

the bottom of the glass pump, and rise in its tube. And when Harry again plunged down the piston, the water came through the valve in the piston, and when he drew it up again it carried up all the water to the top of the tube, where it flowed out of the spout.

"Just as it does in the great real pump," said Lucy.

"And now you do know what I mean by pumping," said Harry.

He pumped on for some time, and then let her take the handle, and work for herself. He questioned her, and made her repeat her explanation, till he was satisfied, and she was satisfied, that she clearly understood that the thing to be done in pumping, and by pumping, is to force the air out of a certain space, to produce a vacancy or vacuum, into which the water rushes and rises. "Or rather," said Harry, "to speak more accurately, is pressed and supported by the surrounding air and water. Perhaps I ought to tell you that there is no *perfect* vacuum. But I will not be too exact with you at first, lest I should tire you. Therefore I will not tell you all the differences between a lifting-pump, and a sucking-pump, and a forcing-pump; besides, I am not sure that I know them all myself. I will not tell you even about water always finding its own level."

"I am very much obliged to you," said Lucy.

"Not will I tell you," continued Harry, "about the weight of the column of water which a certain quantity of air can sustain."

"I think I do know something about that," said Lucy; "or I did know it once. However, thank you for not telling me too much at a time, especially about all the different pumps you talked of. Leave my head quite clear with the vacuum. That I understand now, and the use which is made of it; and I understand all that happens when the piston of the pump is pulled up and pushed down."

"And now that you know," said Harry, "what pumping is, I will ask mamma to let us go to the great pump in the yard, that you may see, Lucy, the same sort of thing in large that you have seen in small."

Their mother went with them to look at the pump in the yard. The handle was so high that Harry could not well manage to use it; but his mother called for one of the servants, who pumped for them.

The servant filled a tub with the water which he had

pumped up; and, as he lifted it to carry it away, he said that he and all the servants in the house were very glad that the pump, which had been out of order, was now well repaired, because it had been great labour to them to go to the windlass-well in the garden for water whenever it was wanted, and to bring heavy tubs of it many times a day. This observation made Lucy the more sensible, as she said, of the great convenience of a pump.

"This is a really and truly useful machine," continued she; "useful to great, great numbers of people, for the commonest business, that must be done every day, and almost every hour; and it is as easy for ignorant people to use as for the most learned—what an excellent contrivance! How happy the man must have been who made the first pump when he found it would do, and felt the water coming, and saw it pouring out at the spout!"

"Delightful!" said Harry.

"Now, Harry, my dear, tell me something about the airpump."

"No, no, my dear, that would be too much," said Harry, looking very prudent. "One pump a day is enough for *you*. I will keep the airpump till to-morrow."

After all this wisdom, what did they do next? How did Harry and Lucy spend the remainder of this morning, two whole hours!

If we tell we shall not be believed, except by those who are themselves children, or by those who know children right well, and their sudden falls from the heights of wisdom to the depths of folly.

Harry and Lucy spent all that remained of this morning in pumping up, through the little glass pump, the water of a puddle in Harry's garden. They could have ladled it all out in three minutes, and two moderate sized tubs would have held it, and have carried it all away. But this would have been too obvious, too easy a way of going to work. It must all pass through the glass pump: and so they worked on till their backs ached, and till the dirty puddle-water had so soaked into the leather of the piston, and so clogged the valve with mud, that it would move no more.

During this pumping and draining of the puddle many mishaps befell Harry's trousers and Lucy's clean

frock—clean no more! It may be recorded, for the advantage of little washerwomen, who, with hands unskilled, may unadvisedly attempt to wash out fresh spots, that the more Lucy tried to get rid of hers the more they appeared. What seemed quite out while it was wet, came in again as soon as it dried. And the spots spread into blotches, with obstinate edges of yellow; so that altogether the frock, instead of looking better for these operations, was worse than ever!

Before it was half dry—oh, how unlucky!—before it had half dried, after dip and scrub the fifth, the sound of carriage-wheels was heard—morning visiters! Their garden was full in sight of the house. Up jumped Harry upon what he called his throne, a heap of stones, from whence he had a full view of the carriage. It was one he had never seen before. Lucy clambered after him to share the exalted view from his throne, and to assist his judgment with her eyes and her imagination. A lady was getting out of the carriage. Lucy did not know who it was, she confessed, but she imagined that it must be a certain Mrs. Hanbury, who owed her mother a visit.

"I am sure it is Mrs. Hanbury, and I dare say that her daughter is with her; therefore I will not go in, for Miss Hanbury is always very fine, and I should not like that she should see me in this frock, in this sad condition. And, oh! Harry, they must not see you in those trousers. I will show you how Mrs. Hanbury and Miss Hanbury would look at us. We will not go in."

"Go in! upon no account," said Harry. "As to my trousers, I do not care what your fine Miss Hanbury or Mrs. Hanbury think, or how they look at them, or at me; but I hate going into a room where there are strangers."

Harry observed, however, that notwithstanding Lucy's certainty that the visiters were Mrs. and Miss Hanbury, no girl got out of the carriage, and there was a gentleman.

"How can that be?" said Lucy, "for there is no Mr. Hanbury. Let them be who they may, we will not go in," repeated she.

To this Harry heartily assented. He disliked *morning* visiters particularly.

"So do I; so does everybody," said Lucy. "I hope they will not see us from the house. I hope mamma

will not send for us. Harry, we had better sit up in your observatory, in the great sycamore-tree."

"Come up then this instant," cried Harry. "Give me your hand, and I will pull you up."

In Harry's observatory, in the great sycamore-tree, they both sat snugly for some time, till he saw through the branches some people standing at the drawing-room window. That they might not be seen by these people, Harry advised leaving the observatory, and removing a step higher, into what he called his dark attics, where the branches were so thick that he was sure no morning visiters could see them, or think of looking for them: he had sat there many a time, he said, while ladies had passed under the tree chattering, without ever spying him. Scarcely, however, had they mounted, and safely lodged themselves in the attics, which, to say the truth, were ill able to hold two lodgers at a time, when Harry exclaimed,

"It is all over with us! there is mamma herself at the window, beckoning to us."

"But she cannot see us," said Lucy.

"Certainly not," said Harry, "unless she saw my white trousers, when I was clambering up here into the attics."

"White trousers! Oh no, I am sure she did not," said Lucy.

"But there she is," said Harry, "waving her handkerchief, Lucy."

"Do not go, do not go in; for now I have a green streak worse than all the rest," said Lucy; "I am sure mamma does not see us, and I dare say she does not want us really herself; but perhaps Mrs. Hanbury asked for me, and mamma just beckoned."

The signal was repeated at intervals two or three times. Lucy had some doubts, but the fear of Mrs. Hanbury's seeing her dirty gown prevailed. The handkerchief ceased to wave, and they remained in their tree nearly an hour, a much longer time than they had expected. Harry had been resolute from the first, and had no waverings during this hour. As he sat quite at ease in his tree, he said, "Now is a good time to think of the puzzle my uncle gave me, about a three gallon, a five gallon, and an eight gallon vessel." Lucy interrupted him several times, by scrambling up and down to see if the carriage was gone, or whether mamma

waved her handkerchief again. At length, having succeeded in solving his problem, he held her fast by the gown, insisting upon her sitting still and thinking of it, which, as he assured her, would make the time appear to go much faster. "There was a gentleman who had two haymakers. One hot day they worked very hard making hay, and when they had finished the hay-rick, late in the evening, the gentleman called them to his hall door, and said, 'My good men, you must be very thirsty, I will give you some beer to drink. Here are eight gallons for you; but you must divide this beer so that each of you may have exactly half, and this you must do before you drink a drop of it.'"

"That was very easily done," said Lucy; "each was to have four. What puzzle is there in this?"

"Stay, stay, Mrs. Quick-Quick, you will be puzzled yet before you have done. The gentleman had only three vessels in his house, it is said; the first held eight gallons—the beer was in this; the second held five gallons, and the third three gallons, and these two were empty. Now manage it as you will, Lucy; and with these vessels divide the beer so that you can prove to me that each man has four gallons exactly. You may pour the beer backwards and forwards as often as you please, from one of these vessels to another."

Lucy began, and poured from one to another in imagination for some time, without success; pour how she would, there was at the end of her measures always five gallons in the eight-gallon vessel, and three in the five. At last she perceived how it could be done, and showed how she could prove to Harry that she had divided it equally; "four gallons, Harry, in the eight-gallon vessel, and four gallons in the five-gallon vessel."

So completely had her attention been absorbed by this puzzle, that she had not heard the sound of the departing wheels of the visitors' carriage; and when she again peeped out of their hiding-place, they were surprised to see that the carriage was gone.

When they went in their mother told them that she was sorry they had not sooner made their appearance, because the lady and gentleman who had been with her were remarkably agreeable people, and had told many things that were entertaining and interesting.

"Then, mamma, it was not Mrs. and Miss Hanbury?" said Lucy; "how very provoking. I am sorry, mamma,

we have missed hearing entertaining things. Who were the people?"

"Sir Rupert and Lady Digby, friends of your father's."

"I never heard of them before," said Lucy.

"Very likely, my dear."

"Mamma, what sort of entertaining things did they tell?" said Lucy.

"They gave us an account of a shipwreck, which happened lately on part of the seashore near the place where they live."

"Oh, mamma! tell it me," cried Harry.

"Yes, pray, mamma," said Lucy.

"First tell me, did not you see me beckoning and making signals to you to come in, my dears?" said their mother.

"Yes, mamma, we saw you," said Harry; "but we thought that it would be tiresome, and we did not like to go in; I liked better to go on with what I was about."

His mother told Harry that she would not have beckoned to him unless she had thought it was worth his while to come in; "and," added she, smiling, "you must now abide by your own choice, for I will never tell you of the shipwreck."

"Pray, at least, mamma, tell it to Harry," said Lucy, "because it was all my fault that we did not come in. I did not like to come, because—look at my frock, mamma."

"It is very much soiled, indeed," said her mother.

"With the water from my puddle and my glass pump, mamma," said Harry; "that was my fault."

Her mother asked Lucy why she could not put on another frock. "Have not you any other, Lucy?"

"Yes, mamma," said Lucy, colouring, "I have; but I could not put on any of them, because one is so short, it comes up to here; and I forgot to let down the tucks. And another has a great tear in it; I intended to have given it to be mended this morning; and one sleeve is half out of the third, mamma. I tore it last night, as I was reaching down a book from the uppermost shelf."

Her mother said that there must be no more experiments of any kind till Lucy should have these things mended.

"I know that is quite right, mamma," said Lucy. "I expected you would say so. I will go up to my room directly, and let down the tucks. But, mamma, while I

am away, *could* you be so kind as to tell Harry the story of the shipwreck?"

"I *could*," said her mother, smiling, "but I will not In the first place, I should be sorry to tell it when you were not present; but I do not intend to tell it to him at all; for if I were to repeat to him every thing entertaining which I heard this morning, he would depend upon my doing the same another time, and he would not exert himself to conquer that feeling of bashfulness which prevents his coming into a room where there are strangers, and which makes him always say, 'I would rather stay out of the room, and go on with my own affairs.'"

"Now, brother, for the airpump," cried Lucy, "as you used to say, 'Now, papa, for the barometer.'"

"My uncle," said Harry, "has been so good as to lend me his portable airpump to show you. Was not it good of him to lend it?"

"Very good indeed," said Lucy; "and how convenient to have so many things portable! *Portable* barometer, *portable* hygrometer, *portable* airpump."

"Now, Lucy, recollect what was the great thing to be done in pumping," said Harry.

"Was not it to make a vacuum?" said Lucy, hesitating, as if she was afraid of making a mistake.

"Yes, to be sure, my dear," said Harry. "Be quite certain about that."

"I am quite certain," said she; "I was only afraid to say it at first, lest I should not be right."

"But do not be afraid. When you know a thing, know it very firmly. The truth cannot alter between yesterday and to-day; nor can the truth ever alter, you know."

"That is a great comfort," said Lucy. "Was not it Boyle who invented the airpump, or was it Torricelli?"

"Neither," said Harry; "it was that poetry you repeated which put that mistake into your head. And when once one has got any thing wrong into one's head there is no getting it out again. But you are partly right. Boyle improved the airpump very much, and it is sometimes called the Boylean vacuum, that is, Boyle's vacuum. But Boyle was too honest a man to claim for his own the first vacuum.—I mean the first making use of it for the airpump. He knew, and always said, it was Otto Guerick's invention."

"Well, I dare say it was," said Lucy; "you need not say any more about it. I do not care much who made the first vacuum, nor who first made use of it for the airpump."

"You do not! Lucy, my dear, consider what you say. Suppose I had invented the airpump, or something as great, would you, my sister, like that somebody else should take from me the honour and glory of the invention?"

"No, I should not," said Lucy; "but you are my brother, and alive; and to be sure I should be anxious that you were not robbed of the glory. But those other people, Mr. Otto Guerick and Mr. Boyle, are nothing to me; besides, they have been dead and buried long ago, and what signifies it now to anybody?"

"It signifies a great deal," said Harry. "Suppose it was my father, or my grandfather, or my great grandfather, should not I care? would not you? Then so would Otto Guerick's or Boyle's children, or grandchildren, or great grandchildren, if there are any living. And there is a great family of Boyles, I know; and do you think that for the world they would give up the Boylean *vacuum?*"

"I suppose not," said Lucy. "But now let us go on to the airpump itself, and the vacuum, let it be whose it will."

"So we will," said Harry; "but before I show it to you, remember, that what you are going to see is a pump for pumping out air, not for pumping up water. So put water quite out of your head."

"I have put water quite out of my head. I understand that the airpump is to pump out air. But, brother, before you begin, let me say one thing."

"Say it then, if it is not poetry."

"No, it is only that I think a pair of bellows is a sort of airpump. Hey, Harry?"

"Well, that is not foolish, Lucy. You may call a pair of bellows a sort of airpump; only that bellows never could be a right airpump without two valves. But do not go on thinking of them all the time I am explaining to you. Now look at my uncle's airpump. You see this glass," continued Harry, and he pointed to a large glass bell, which stood over a sort of frame or stand. "Lucy, what do you think is in this glass?"

"Air, I suppose," said Lucy.

"It is full of air, and of nothing else," said Harry.

"The thing to be done is to get all the air that is in the bell out of it. And that is to be done by means of these pumps," continued he, pointing to two tall cylinders of brass, which stood upon the stand with the glass bell; they communicated at the bottom with a pipe, which opened into the bell. There was a handle, by which, as he told Lucy, she could move the pistons of these pumps up and down.

"Just in the way in which the piston moved up and down in the water-pump yesterday," said she. "I see, I see; it is all nearly the same thing, only that this pumps air out, as you said, and the other water. I understand it all perfectly."

"Stay, stay, Mrs. Quick-Quick, you do not understand it all perfectly yet. You see only the likenesses, but there are differences which you do not see yet, and cannot, my dear Mrs. Quick-Quick, because it takes a great deal more time to see the differences than to catch the likenesses, Mrs. Quick—"

She put her hand upon his mouth before he could repeat the offensive words.

"Brother, do not call me Mrs. Quick-Quick, and I will be as slow as you please, and I will not tell you of any of the likenesses I see. I will be quite silent, and only nod my head when I understand ever so perfectly."

"Then look at the airpump which is before you," said Harry, "and observe what I do. I am going to move the handle which you see at the top, which will raise up one of the pistons. What is underneath the piston?"

"Nothing," said Lucy, at first; but afterward she added, "I believe there is a vacuum."

"True. And what happens directly?" said Harry.

"Air comes in directly to fill it, I suppose," said she.

"Where does it come from?" said Harry.

"It must come from the bell through this pipe," said Lucy, "which leads from the bell to the bottoms of the pumps."

"Then, when that happens, there is less air in the bell than there was before. Is not there?" said Harry. "Now move the piston down again, and what happens?"

"You would press the air that is under the piston back again up the pipe into the bell," said Lucy, "if there is not a valve at the bottom of the pump that shuts against it, and prevents it from going back. But though I do

not see it, I suppose there is such a valve, because you told me that it was necessary in all pumps."

"You suppose rightly, and you remember very well," said Harry. "There is such a valve, and it prevents the air from going back into the bell when I push the piston down. But what becomes of the air?"

"It comes out into the open air through the valve in the piston, I suppose."

"Very true. Now I will move the handle again, and repeat the operation. I should have told you that we are assisted in pumping by the expansive force of the air."

"I do not understand that," said Lucy.

"Yes, you do, my dear, if you will only recollect the experiments papa showed you with a bladder," said Harry.

"Ages ago!" said Lucy.

"Yes, you remember seeing the bladder swell out with the expansive force of the air; and you may recollect that, after blowing in air for some time, when we tried to force in more air we could not; the bladder swelled out so that we could hardly hold its mouth together to tie it."

"I remember it," said Lucy.

"If we had let go the string," said Harry, "and the mouth of the bladder had opened, what would have happened?"

"The air would have forced its way out," said Lucy.

"Yes; air, you know, will expand, and fill every empty place. Now I have pumped out all the air that I can from the bell, and now that it is as empty as we can make it, we call it a vacuum, though very accurate people would tell you, Lucy, that it is not a perfect vacuum."

"It will do for me," said Lucy, "and I think I understand the airpump really now. Is there any other difference between it and the water-pump, brother? You said there was a difference."

"I did say so, and I will explain to you what it is, if you will answer my questions patiently. What was it in the glass water-pump that you saw yesterday, that pressed up the water into the vacuum below the piston?" said Harry.

"It was the outer air; the weight of the outer air pressing upon the surface of the water that was in the tub, forced the water up into the tube."

"True; the same in all water-pumps," said Harry. "But here is no water for it to press upon. How then is this vacuum filled?"

"By the weight or force of the air itself only, I believe," said she.

"What air?" said Harry.

"It must be the air in the bell," said she, "for I see no other. But that is so little that there cannot be weight enough in that."

"No," said he, "it is not by *weight* that this pump acts, but by the *springiness* of the air itself. This is the difference which I wanted you to observe, between the airpump and water-pumps."

"By the springiness of the air?" said Lucy.

"Yes," said Harry, "you felt the force of that springiness in the bladder when it was full of air."

Lucy said she should like to feel it again. She had almost forgotten it. Harry blew into a bladder, and filled it with air, and when it was full bid her try to press it together; when she tried to do it she perceived the sort of resistance that it made, and she felt the force with which, after she had squeezed it, it returned to its former place and form.

"The same springiness," said Harry, "or what is called the elasticity of the air in the bell, is what fills the vacuum below the piston each time it is drawn up. Now here is the description and plate of it in Scientific Dialogues, and this is all that you need know about it at present. Stay, I will just look at the print of the airpump in Rees's Cyclopædia, and see if I have left out any thing that I ought to tell you."

As he opened the book, and as Lucy saw the engravings, she looked a little alarmed.

"There seem to be as many different airpumps as hygrometers," said she, sighing.

"Do not be afraid, I am not going to show them to you all," said Harry; "but now that you know the general principle, you would soon feel it easy, as I did, to understand them."

"Oh no!" said Lucy, "there seem to be such a number of pipes and valves, and little *a*'s and *b*'s, and *p*'s and *q*'s."

"They only relate to the contrivances to prevent the outer air from coming in, while we are pumping the air out of the vessel that is to be emptied, which it is con-

stantly trying to do. One pump is better than another only as it does this most effectually and most easily, and as it more perfectly empties or exhausts the vessel. By-the-by, I should tell you that this glass vessel is called a receiver, and when it is emptied it is called an *exhausted receiver*. I was puzzled at first by those words, *exhausted receiver*."

"Thank you, Harry, for remembering that for me."

"Now, my dear Lucy, you shall work a little at the airpump yourself, as you did at the water-pump yesterday."

"Oh thank you, thank you," said she, joyfully; "there is nothing like working one's self; it fixes a thing so well in my memory. I remember the look and touch of the things much better afterward."

While Harry was placing the machine, so that it should be convenient to Lucy, she turned to look at the book of engravings that lay open on the table.

"How well this airpump is done," said she. "It is very like my uncle's; not quite, perhaps. I will take care to mind about the *differences*."

"This is very like it," said Harry; "there is no difference of any consequence."

"If we had not had my uncle's," said Lucy, "I think you could have made me understand the airpump quite well from this engraving; that is, after my having seen the glass pump yesterday, and its valve and the piston; but without that I could not have understood it from this representation, because I see here only the outside of a pump. Even though you had described the valves, and explained them to me ever so clearly, I should not have understood them so well as by having seen and touched them, and moved them myself."

"Certainly," said Harry; "but next to seeing the real thing, these engravings or drawings help one very much. Look, though you see only the outside of the pump in that perspective view, here is the inside of an airpump all laid open for you. You know what is meant by a section!"

"Oh! yes," said Lucy. "Suppose any thing to be cut in two, what you see inside of each part, when they are separated, is a section. Papa explained that, and showed it to me, when he cut a lemon in two for me. I remember this minute, as well as if I saw it before my eyes, the look of the lemon, with the pippins cut in half,

each in their little cells, the cells cut open too; and I remember—"

"Very well, my dear," interrupted Harry, "you remember very well what is meant by a section, therefore you will understand this plate and this figure. But, Lucy, never be ashamed to tell me if you do not understand; you know I have but just learned these things myself, and I remember the odd mistakes I used to make, and the puzzles I was in when papa was teaching me."

Lucy looked at the engravings now without alarm, because, as she knew what they represented, they did not puzzle her, and she was not afraid of being tired.

After having looked at the section, she said it made the whole as plain to her eye as if it had been made of glass. Something farther she said to herself about a man's having a window in his breast; but either she did not say it loud enough for Harry to hear, or he did not think it much to the purpose, for without attending to it he shut the book, saying, "Now we have had enough of the prints. I thought just now you were very eager to work the airpump yourself, Lucy."

"So I am still," said Lucy; "only it was not quite ready, and I looked at the prints between times. Now let me pump."

"Pump away; this way," said he, showing her how to hold the handle, and how to move it backwards and forwards, and how she worked two pistons at the same time.

She worked it, but not without difficulty. After she had pumped for some minutes, she found the difficulty increasing, and asked from what this arose.

Harry said, from the resistance made by the pressure of the outward air, which becomes greater as the receiver is more and more exhausted. He took off the receiver, and put her hand over the hole at the top of the pipe which communicates with the pumps, and bid her move the pistons with her other hand gently. She did so, and felt that part of the palm of her hand which was over the pipe drawn in. Her brother repeated, "gently, gently," as she moved the handle. Indeed, soon there was no occasion to say so to her, for she felt the palm drawn in so as to be quite painful, and she grew red with fright.

"Oh! brother, it hurts me very much: I cannot take my hand away. What shall I do?"

"Stop pumping," said he, "and do not be frightened; there is no danger."

She stopped pumping, and her brother turned a screw, so as to let the air into the receiver. This relieved her hand. She held it up to show him a purple circle all round the inside of the hand.

He pitied it a little—a very little. Lucy thought not quite enough.

"I know," said he, "exactly how much it hurts you, because I have done the same a hundred times to my own hand. My dear, I wanted you to feel as I did myself. There is, as you said, nothing like feeling to make one remember well. What do you think caused this?"

At first Lucy answered that she did not know.

"Because you are thinking of the pain in your hand," said he.

"That is true," said Lucy, "but it is pretty well over now. What did you ask me?"

"I asked you what caused that kind of sucking in of your hand into the exhausted receiver?"

She thought for an instant, and answered,

"I believe it was the pressure of the outer air, which was trying to get in at that hole to fill the vacuum, and which was prevented by the palm of my hand, which it then drove in as much as it could. Well, now I am sure I have *felt* 'the pressure of the viewless air;' and now you must let me repeat the line,

"'The spring and pressure of the viewless air.'"

Harry repeated it after her, declaring it was a very pretty line, besides, it had some common sense in it. Lucy had said it quite at the right time, when it did not interrupt him, or any thing that was going on. He was so much pleasd with it, that he begged of her to repeat all those lines again for him; and when they went out to their garden soon afterward, instead of beginning to dig, he desired her to say the lines once more, for that he must learn them by heart. Thus he learned from her some of her taste for poetry, while she acquired from him some of his love of science.

In repeating these lines, Lucy observed which of them alluded to the barometer, and which to the airpump.

When she had first learned them by rote, barometer and airpump had been so jumbled in her head that she could not understand them.

"How up exhausted tubes bright currents flow,
Of liquid silver from the lake below;
Weigh the long column of th' incumbent skies,
And with the changeful moment fall or rise—"

she now knew described the barometer, and the succeeding lines the airpump:

"How, as in brazen pumps the pistons move,
The membrane valve sustains the weight above;
Stroke follows stroke, the gelid vapour falls,
And misty dewdrops dim the crystal walls;
Rare and more rare expands the fluid thin,
And silence dwells with vacancy within."

While Harry was learning these lines by heart, Lucy stopped as she prompted the couplet concerning "gelid vapour" and "misty dewdrops," and objected, "I do not understand about misty dewdrops on the crystal walls. I did not perceive any vapour on the glass bell."

Her brother told her that these lines alluded to a fact which he had not yet mentioned to her, which his father had but very lately told him, and he was not clear enough yet about it to attempt to explain it to her.

Lucy said she was satisfied to wait; that it was best not to know every thing at once, and pleasant to have something to look forward to. But altogether she confessed, that though the airpump was curious and ingenious, to use the air to drive itself out, yet the waterpump she thought a much grander and a much more useful machine. She thought the airpump was not of any use.

Harry smiled, and answered, "So I thought at first. But, my dear, that was owing to my ignorance. And when you know more you will find that the airpump is of great use. There are many experiments in natural history, as papa showed me, that could never have been tried, and discoveries that could never have been made without it. For instance, to give you a little peep into the matter, we could never, without an airpump, have known that a guinea and a feather would fall to the ground in the same time, if there was no air to resist the fall of either of them."

"A guinea and a feather! A heavy guinea and a light feather! oh, brother!"

"Very true, I assure you, as you will see one of these days."

"Harry, now I think I recollect I heard this about the guinea and the feather before, or read it somewhere; and something else too about the guinea's making no more noise than the feather when it falls. You will show me this too, will you?"

"I am not sure that I can, Lucy," said Harry. "I tried in this airpump, and I did not find it was so. The guinea fell on the metal plate here at the bottom, and this plate touches the outer air, and rings, makes a noise."

"I do not clearly understand why it should make a noise when it falls, or why it should not," said Lucy.

"I cannot explain it yet," said Harry; "and I must try the experiment about the noise over again, to make myself sure whether I am right or wrong. I am certain that the feather and guinea came to the ground in the same time, for that experiment I have tried often, and it always succeeds."

"Show it to me now," said Lucy.

"No, not now. But you shall see all this and a great deal more in time," said Harry. "But, Lucy, how could you say that the airpump is of no use? When you know more about it, you will see how much you were mistaken. You will find that all we know about the specific gravities, the different weights of bodies, and a great many curious facts about sound, and I cannot tell you how many delightful experiments and discoveries about the air that comes out of vegetables, and about the growing of seeds and of plants, and other experiments about different kinds of gases, as they are called —I say, my dear Lucy, as my father told me, none of these could have been known without the airpump. And then as to the gases—Oh, my dear, I cannot explain to you yet of what amazing consequence the gases are."

Lucy opened her eyes, and stood looking as if she thought she could never admire enough. After a reverend pause, she simply repeated the word "Gases!"

"My dear, do not ask me about them yet. You are a great, great way yet from the gases. But if you are good I will put you into boiling water to-night at tea, and get you on to steam and the steam-engine."

"Thank you," said Lucy, without knowing clearly what was to happen to her.

"Now let us finish the new road to my garden," said Harry. "But, before we go, I hope you will acknowledge the airpump, besides being very ingenious, is as useful as the water-pump at least. Hey, Mrs. Lucy, you look as if you were not convinced yet."

"I must wait till I have seen and till I can understand all these things, before I can decide," said Lucy.

"Very provokingly prudent and slow all at once," muttered Harry, striking the stones of the new road with his *pounder*.

"Why, brother, how can I possibly say more, when you tell me I am so far from the gases; and I am sure I did not understand a word you said about specific gravities; as to the experiment about the feather and the guinea, I long to see that with all my heart; and I dare say I shall like the others about sound, and seeds, and vegetables, particularly. But these are all curious experiments for grand philosophers, with your airpump; they may be useful to your men of science, brother; but what I say is, that the common pump is more useful to common people every day. And I do say that I like those machines best which are most useful."

All the rest Harry heard patiently or passively, as he went on pounding his road; but when she came to the last words, "And I do say that I like those machines best which are most useful," he threw down his pounder, exclaiming, "You are very ungrateful, Lucy!" and he wiped his forehead, for he was very hot; but, checking himself, he added, "ungrateful to the airpump, I mean."

"My dear, I did not mean to be ungrateful to the airpump," said Lucy, surprised that he could grow so warm about it. "I did not mean to affront the airpump, or you; I am sure I did not know you cared which I preferred. What can make you care so much about the pumps?"

"I do not know," said Harry. "But I was vexed because you would not do justice to the airpump, and you gave your opinion against it without knowing *all*. I thought that you were like that foolish woman, who said to the great chymist, 'Of what use is all your chymistry, if it cannot teach you to tell me how to take the iron-moulds out of my gown?' Lucy, I hope you will never be so foolish."

"Never, I hope," said Lucy; "and I hope you do not think I ever shall."

"No, I hope not," said Harry. "But now I must say for the airpump, there is a use that may be made of it in common every day, in hot weather, to make something that is exceedingly agreeable."

"What can it be?" said Lucy.

"Particularly with sweetmeats and creams," continued Harry. "Very good of pineapple, and pleasant of tea; mamma told me not bad even of water."

"Do you mean ice?" said Lucy.

"Yes," said he, "the airpump can make ice."

"Oh! Harry, I cannot believe that. How can that possibly be done?"

"Go to Conversations on Chymistry, my dear, and you will be answered."

"Very well, I will go to Conversations on Chymistry," said Lucy; "but not till I have dug this bed in my garden, and tied up all my carnations, and fed my white rabbit, and finished drawing the last snake of my head of Medusa, and put by the sulphurs in the cabinet, and practised 'The rising of the lark.'"

"Very little chance indeed, through all the jumble of things, of your remembering Conversations on Chymistry and the airpump," said Harry.

"You shall see," said Lucy; "I have always a good memory for what I wish *to* do."

"HARRY, I have done all that I said I would: I have dug the bed in my garden, tied up my carnations, fed my white rabbit, finished my Medusa's snakes, put the sulphurs into their cabinet, practised my rising of the lark, and read and understood all that you marked for me in 'Conversations on Chymistry.'"*

"Really! you have done a great deal," said Harry; "much more than I expected. I thought the white rabbit would have made you forget every thing else. And do you quite understand all you have read?"

"I do," said Lucy, "for it is very clear. As I was reading, I thought I saw every thing that was described; and after I had finished, I was more anxious than before

* Eighth Edition, vol. i., from page 151 to 160.

to see the experiment you promised to show me. Will you let me see it now, before I forget what I understand, and while my *head is in it*, as you say?"

"I will show it to you as soon as ever I can," said Harry, "with my father's assistance. He says that I must not attempt to try this experiment by ourselves, because sulphuric acid, which must be used in it, is very dangerous to meddle with. If we dropped any of it on our clothes, it would burn holes in them; and if we were to let a drop fall on ourselves, it would hurt us exceedingly. So take care, Lucy, not to meddle with it."

"I will take great care," said Lucy. "I will look, but not touch."

While Harry went out of the room to his father, who was preparing for their experiment, Lucy talked to her mother about the entertaining account which she had just been reading of the method of making ice in India, even in the hottest nights.

"How glad they must be, mamma," said Lucy, "when in the morning they see the ice in the shallow pans which they leave out of doors during the night! Mamma," continued she, "I think that the Emily and the Caroline in this book must have been very happy, seeing all the nice experiments mentioned here, and talking to their mother about them, and learning from her. This Mrs. B. seems to be a very good, kind mother. I should like to know her, if she is really a live person. Is there such a real person as Mrs. B., mamma?"

"Yes, there is, Lucy."

"There is! And are you acquainted with her, mamma?" Lucy asked eagerly.

"I am, my dear."

"You are! And what sort of person is she? Do you like her! Oh! yes, mamma, I see by your look before you speak. You like her very much."

"I do, indeed, Lucy."

"I am glad she is an acquaintance of yours, mamma. I hope I shall see her some time."

"She is more than an acquaintance of mine, she is my friend; and if you deserve it, my dear daughter, I hope that she will some time be yours."

"Oh, brother! What do you think mamma has just told me," cried Lucy, running to meet Harry, who at this moment opened the door, and came in, followed by his father.

"Oh! papa, do you know—"

But observing that her father's hands were full, and that he and Harry were intent upon bringing in the air-pump, she wisely ceased her exclamations, and stopped short in what she was going to say.

"Right to be silent, my dear," said her father, as she stood by without uttering a word all the time that they were preparing to show her the experiment. "It is very troublesome and disagreeable to have little girls, or little anybodies, or great anybodies, talking all the time we are busy preparing experiments."

"Busy and anxious too, you know, papa; for some experiments are dangerous," said Harry.

Lucy had learned, from what she had just read, that sudden evaporation produces cold sufficient to freeze in a vacuum, even when the outer air is much above the freezing point. A thermometer was near the airpump, and Lucy looked at it, as Harry desired she would. She saw that the mercury stood at 65 degrees, and she felt that the room was warm.

Her father placed under the receiver a large shallow saucer, filled with sulphuric acid, and in it a small cup of water, raised on a little stand, with a thermometer in it, as described in Conversations on Chymistry.

He asked Lucy if she knew for what purpose the sulphuric acid was put there.

She said that the book had told her that the use of the sulphuric acid was to attract and absorb what was evaporated from the water before it is frozen.

"And why should it be absorbed?" said her father.

"Because we want to freeze the water," said Lucy.

"True; but you have not explained to me why we desire that the sulphuric acid should absorb this vapour."

"Because, papa, that vapour fills up part of the vacuum, and it must be taken away, and the sulphuric acid does this as it absorbs it."

"She understands it," said Harry. "Now we may go on. Look, Lucy, at what happens—keep your eyes fixed upon the water."

She did so, and she soon saw little bubbles appearing on its surface.

"It is beginning to do something," said she; "but it looks more as if it were going to boil than to freeze."

"You know," said he, "that before water can freeze it must appear to boil."

"Yes, *appear*; I understand why you say appear. That was explained to me in the book."

"Now it begins to freeze," said Harry, "look at the little spikes of ice."

Lucy saw this, and said it was very curious; but still she did not look quite so much surprised and pleased as Harry had expected, because, as she said, she saw only such tiny spikes of ice. She had imagined that all the remaining water in the cup would have been turned at once into a solid lump.

Harry had talked to her about pineapple ice, and various other kinds of ice, which were so pleasant to eat in hot weather, and which he boasted that the air-pump was so useful in assisting people to make; but from the tiny spikes she had seen, she could scarcely conceive that a sufficient quantity could be made for this good purpose. Harry asked his mother if she would give them some cream and some sweetmeat, to make sweet ice-cream; he wished exceedingly to show Lucy that it really could be done in the airpump. Their kind mother provided them with all that Harry desired; but she doubted that they would be able to succeed, as it was difficult even to freeze water. Harry was determined to try, for he had heard that it was a common practice in London to make use of an airpump in making ice-cream. His father warned him that he was mistaken, but that he might try, and that he would then find out what his mistake had been.

Harry put the cream into a small teacup, and Lucy mixed with it their raspberry jelly. They put the teacup into a larger cup filled with water, and this they placed on a little stand, which rested on a saucer filled with sulphuric acid, within the glass bell of the airpump. It happened, as it too often happens to young experimenters, and to old ones also, that their experiments did not succeed. They could not freeze the cream.

They tried to console themselves by eating the cream and sweetmeat. This was, however, but an imperfect consolation to Harry. The honour of the airpump and his own were at stake, and he recurred to the subject immediately.

"I suppose my mistake was in putting the cream and sweetmeat into the airpump. I was only told that the airpump was useful in making ice. How they make the ice-cream with it I cannot guess," said Harry.

"I can tell you that," said Lucy, "for I once saw the housekeeper make raspberry ice-cream."

"Have you?" said Harry; "and how did she do it?"

"She put some cream and sweetmeat into a tin cylinder: tin I believe it was, or pewter. And this she surrounded with a great deal of pounded ice and salt. Then she kept turning and turning the cylinder round, with the cream in it, till at last it was all frozen."

"Oh! oh!" said Harry, "then now I see how it is. The airpump produces ice enough to freeze the cream. That must be the way it is used."

"But how can it produce it in such quantities as would be necessary? It would be a year, at the rate I saw it going on with a little cupful of water," said Lucy.

Harry acknowledged this, and they appealed to their father.

He told them that, for this purpose, much larger airpumps than they had ever seen would be necessary. That consequently a greater vacuum was produced, and more water frozen.

"Then it is true, Lucy, you see, the airpump does make the ice that makes the ice-cream, and it is used for this purpose in London. Is not it, papa?"

"Not in London," answered their father; "it is too expensive a process to be of much advantage in this country; but I believe it has been found useful in India."

"In India! There, Lucy, you see how useful it is, and how far its fame goes," said Harry.

"Did they really send an airpump made in England to India for this purpose?"

"Yes," said her father. "And when we go to London, I will show you Mr. Carey's apparatus for making ice."

"Oh! thank you, father; and I shall really see it made, not in little spikes, but in quantities," said Lucy.

"Now, Lucy, you will acknowledge," said Harry, "that the airpump is useful for common purposes."

"I will; I do," said Lucy.

"And you will have much more to acknowledge on this subject by-and-by," said her father; "you will see other purposes for common life to which it is applied."

"Oh! what, father?" cried Harry.

"That I will not tell you now, Harry."

In the evening, before tea-time, Harry and Lucy played at spillikens, and afterward a game of chess, in which Harry was beaten; because he was thinking of something he was going to tell Lucy about the steam-engine, and he missed seeing a rogue of a knight that had got so close to his king that he could not stir without being checkmated.

"Now for the steam-engine, which you promised to explain to me," said Lucy.

Harry was afraid that he could not, and, turning to his father, asked him to explain it. But his father desired that he would first try what *he* could do.

"This will be of service to you, Harry, for you will be then certain whether you comprehend it yourself or not. People are never sure they understand any thing perfectly till they have explained it to another. If Lucy is puzzled I will help you out of your difficulty, whatever it may be."

Harry said he would try, and began with these words:—

"In the first place, a steam-engine is a machine—" There he stopped, and began again with,

"In the first place, Lucy, you must know, that the machine called a steam-engine was invented—" He stopped short again, and a third time he attempted it, but he hesitated, and blushed, and turning again to his father, he said, "I cannot explain it before you, father. I am so anxious. It is very odd. I am not the least afraid of you, you know; but I feel so ashamed and anxious. I think I should do it a great deal better if you were not by."

"Very well," said his father, laughing; "then either you or I must go out of the room, it seems. Luckily for you, I am just going into the next room. Is that far enough off? though the folding-doors are open, I assure you I shall not hear you."

"That will do perfectly," said Harry.

"But what will you do about mamma? She must stay to make tea," said Lucy. "Look, here is the urn coming in. Had not you better come out into the hall with me, Harry?"

"No, no," said Harry, "I do not mind mamma; and, now I think of it, I want the urn. Lucy, look at the steam coming from the top of that urn; do you recollect,

a great while ago, my father's holding a cold plate over the steam coming from the urn?"

"Yes," Lucy said, she remembered it well, though it was a great while ago. She remembered that the cold of the plate had turned the steam into water again, condensed it. She recollected the drops on the plate, which afterward ran into each other, and down into little streams, when the plate was sloped.

"Yes," interrupted Harry, "you have recollected enough of that; you are clear then that cold can condense steam, that is, can turn it back again into water."

"Perfectly clear," said Lucy.

"Now recollect another thing," said Harry; "which took up most room, the steam when it was steam, or when it was turned into water?"

"It took up much the most room when it was steam," said Lucy. "I am sure, that cloud of steam which you see rising from the tea-urn, and which takes up so much room in the air, might, if you held a cold plate over it this minute, be condensed into a few drops, which would not half fill a teaspoon."

"Very true," said Harry; "now do not think any more about that: but do you recollect our talking, a great while ago, about the teakettle's boiling over, as it is called; and do you remember my saying, that if the top of the teakettle was screwed down tight, and if the spout was stopped, so that no steam could get out, that I thought the teakettle would burst?"

"I remember it all," said Lucy; "and papa said you were very right; and I remember afterward the bursting and exploding of my chestnuts; and the story papa told us of his pouring hot lead into the damp elder to make a pencil; and the fact* I read about the bursting of a little hollow brass ball, in which there was water, that turned to steam, and which caused an explosion that blew a whole foundry to pieces."

"Then you have some idea of the power of steam when it expands," said Harry.

"To be sure I have," said Lucy; "I know it is terribly great, bursting and killing people, and tearing away! How frightened I should have been, if I had been papa when he was a little boy, when the lead bounced up to

* Scientific Dialogues.

the top of the ceiling. I am sure I was frightened enough when my own horsechestnuts bounced."

"But if this terribly great power," said Harry, "is carefully used, and cleverly used, it will do, as you shall see, the most surprising and the most useful things; it would raise water as high as the house, and higher, from the bottom of the deepest mine: it could raise the weight of this room, and all that is in it, as high as the top of the highest tree, and higher."

"Oh, brother! brother!" said Lucy.

"It is quite true; it can do more in an hour than two hundred horses and fourteen hundred men. It can drag loaded wagons full of coal, such as you have seen going step by step, the horses pulling hard—It can pull these wagons up as easily as I can pull your little cart."

"My dear brother, how can I believe it!" said Lucy.

"It can drive across the sea, against the power of the wind and tide, a great ship, with all the people in it, and all their horses and carriages, and all that they have in the world."

"Is it really possible?" said Lucy. "I have heard people talking of steamboats, and of the working of steam-engines; and I remember papa's asking a gentleman who was here the other day, whether his steam-engine was a hundred horse power. But I never knew how this was, nor could I conceive that steam could do all this by itself. Only steam like that?" said she, fixing her eyes upon the steam that still came from the tea-urn.

"Yes, only steam like that," repeated Harry. "Think what we men can make it do at our bidding."

"Really and truly, Harry," said Lucy, "it does more at men's bidding than any of the genii in the Arabian Tales, more than any of the slaves of Aladdin's lamp, for the hardest working of them could only be made to carry one house."

"Very true, indeed," said Harry, and for once he was pleased with an allusion.

"But," continued Lucy, "I should be very much afraid of its doing some great mischief some day, like the African magician. Do you remember?"

"But, my dear," interrupted Harry, "do not tell me any thing more about the African magician."

"Only this one thing, Harry; if you would let me get it out of my head I should attend so much better."

"No, my dear Lucy. Is it not very hard upon me that you are to say every thing that comes into your head, and that puts out of mine all that I want to remember about the steam-engine for you?"

"I beg your pardon," said Lucy, "I will not say a word more of the African magician. Go on."

But poor Harry could not go on immediately. "Where was I?" said he to himself. "What was I going to say?" As he spoke, he rubbed his forehead first, and then ran his fingers through his hair from the roots upwards, till it was all pushed up, and stood erect, "like quills upon the fretful porcupine."

"Now I recollect what I was going to say," cried Harry. "Look at the tea-urn, Lucy. Ah! but now it is too late; there is not steam enough—it is not strong enough to do what I wanted you to see. But at first, when the water was boiling, and the steam rushing out at the top, you might have seen it pushing up the lid of the urn till the steam got out, then the lid fell, and lay still till more steam was formed, and pushed it up again. I wish you had seen it going up and down."

"I have often seen it," said Lucy, "and watched it moving, because sometimes I was afraid the top would be quite lifted up, and blown off."

"And so it would," said Harry, "if it were not for these little holes, look here, through which the steam escapes, and which were made on purpose to let it escape, without blowing off the top, or doing any mischief."

"That is very prudent; I am glad the holes are there," said Lucy.

"But suppose they were not there," said Harry, "and the top left loose as it is now. If the water boiled *well*, as people say, if a great deal of steam came rushing up, and pushing out through this place where the top goes on, you know the top would be lifted up. And suppose I lay on the top this weight," continued he, taking up from the table a small weight which was used for keeping down papers; "and suppose I put a lamp under the urn so as to keep the water boiling, and sending up fresh steam, what do you think would happen then?"

"I am not sure," said Lucy. "It would either burst the urn, or lift up the top with that weight upon it. It would, I am sure, lift up the top and weight, because

that would be the easiest way for the steam to get out."

"To be sure. It would require much less force," said Harry, "to lift this little weight than to burst the urn. The expansive force of steam, you know, I told you, would lift the house. Now suppose that, instead of that urn, with a little lamp under it, there was a great fire, as large as a kitchen fire and larger, and a great iron boiler, as large as the boiler you have seen in the kitchen and larger, with water boiling in it; and over the mouth of that boiler suppose we put a cylinder like the body of a pump, as large as that in the yard, and closed well round at the place where it is put in, so that the steam of the boiling water can get out no way but up the cylinder."

"Then," said Lucy, "how the steam would rush up through the valve in the piston! What a cloud of steam would come out at the top!"

"Stay, stay, Lucy; I was going to have told you that in this piston there is to be no valve, it is to be a tight stopper. Now suppose, before I let the steam in, that I have the piston down at the bottom of the pump."

"Why then, before you let in the steam, you must put a great weight to keep the piston down, or it would be thrown up to the ceiling, as the lead in papa's pencil-case was."

"And I believe," said Harry, "your great weight would be thrown through the ceiling, and would break it to pieces. Consider, my dear, if the small quantity of water that was in papa's elder pencil-case could, when turned into steam, force the lead up to the ceiling, and if the small quantity of water that was left in the little brass ball could burst and blow up a whole foundry, such a quantity of steam as this would be able to lift up and blow up this room, and all that is in it."

"But if that is your only way of lifting great weights, and of lifting the house, I do not see how it can be useful."

"Patience, Lucy. Suppose that we know beforehand the weight of whatever we wish to lift, we can calculate, and lessen the fire, and lessen the steam, till it is just enough, and no more than enough, to lift the weight gently up, to whatever height we please—suppose now to the top of the pump. Then you do no mischief, you see."

"Very well," said Lucy, "if you can calculate exactly, and make no mistake. That is very nice."

"But now suppose you want to do this more than once; to lift several weights, one after another—could you do it? You have the piston and the weight up at the top, and the steam in the cylinder of the pump."

"I do not know," said Lucy; "for I dare not take the weight off the piston. I dare not touch it."

"I would not advise you to touch it, indeed," said Harry.

"Then what can I do?" said Lucy.

"Think," said Harry.

"But the idea of the steam going on, coming up through the pump, frightens me. I will tell you what I would do; I would put out the fire directly, throw water upon it."

"Very well thought of," said Harry, "but then there is steam in the boiler."

"I would throw water into that if I could, but I cannot get at it. I would throw cold water all over the outside, and that would cool the steam."

"But still there would be the steam in the body of the pump," said Harry.

"And I cannot throw water into it because of the stopper," said Lucy. "Well, I will throw cold water over it, all down the sides, and over the piston at top, and cool it, and make it as cold as the plate papa held over the urn, and colder; then it would condense the steam within, and turn it into a very small quantity of water."

"Then what would happen?" said Harry.

"The piston would fall down—there would be nothing to hold it up. The steam would be all gone."

"And what would there be, or would there be any thing in the place of the steam?" asked Harry.

"There would be nothing but a little water; there would be a vacuum, all but those drops of water," said Lucy.

"Very well, indeed," said Harry. "Now you have the piston down, how will you raise it again? I want to have another weight brought up."

"Then, you know, I must light the fire, and boil the water again," said Lucy.

"Ay, and wait till the cylinder is heated too; for, till that is heated, it will condense the steam," said Harry.

"Certainly," said Lucy, "you must wait till it is hot."

"But it would be very inconvenient," said Harry, "to wait while you light the fire, and boil the water, and so on. Cannot you find any better way of condensing the steam, without putting out the fire every time?"

Lucy thought for a few moments, and answered, "Perhaps, without putting out the fire, it would do as well if I could but let cold water into the boiler, and into the cylinder of the pump."

"But why into the boiler," said Harry.

"Because the fresh steam would come up continually if I did not prevent it," said Lucy.

"But suppose," said Harry, "you have condensed the steam in the cylinder, and you only want the vacuum for an instant or two, just to let the piston fall; and suppose that for that little time the steam from the boiler could be prevented from coming in; I need not tell you how, but it can."

"Then I need not put out the fire, but I may condense the steam in the cylinder," said Lucy; "that will be much more convenient, because afterward the steam will be ready to be let in again, under the bottom of the piston, if you want another weight to be sent up. But still I do not know how to get the cold water into the body of the pump, I mean into the cylinder, to condense the steam."

"The steam," said Harry, "is let off into a separate vessel, called, from its use, a condenser. This vessel is surrounded by cold water, so that the steam is condensed as soon as it comes into it."

"And is this all the steam-engine?" said Lucy.

"No, my dear Lucy, it is only the general principle. I cannot explain all to you, I should only puzzle you. There are different sorts of steam-engines. In that invented by Mr. Watt, the expansive force of the steam is used in different degrees, to raise the piston, and to force it down."

"I did not know that the steam was ever let in above the piston," said Lucy.

"Yes, it is. I did not tell you that at first, lest I should puzzle you, and I will now tell you exactly how it is done. And there is a great deal more to be explained, about the ways of making the steam-engine

raise weights, or water, or work machinery, in different directions. Ours was but an awkward way of raising weights, by putting them on the top of the piston. Suppose I want to raise water from a pond, you must put a beam out from the top of the piston, like a scale-beam, and with this you might work the piston of a pump fastened at the other end of this beam."

"Very convenient!" said Lucy, "and very simple."

"There are a great many other contrivances," said Harry, "and ways of making it turn wheels, and pull and push sidewise, or in any direction in which you want to have work done, or force applied; but I should tire and puzzle you to death if I were to tell you all at once. Papa took several days to explain to me the parallel motion, and the fly-wheel, and the sun and planet motion, and the eccentric."

"Oh, my dear brother!" cried Lucy, stopping her ears, "this would puzzle me to death indeed."

"Therefore, my dear, I tell you, I will not say one word about any of these things to-day, but I will leave your head quite clear, as I hope it is, in the general principle, as papa calls it. And here he comes with his letter in his hand."

"Mamma is beginning to pour out tea," said Lucy, "let us go to her."

"Stay one minute, Lucy," said Harry. "Now, pray, when you are called upon to explain to papa, be quite steady. Do not be a coward, and fancy that you do not know what you do. And do not be too quick neither. Above all, do not go the least beyond what you really know. Do not put in any of your '*It's like this*,' or '*It's like that*.' When you have no more to say, stop."

"I will," said Lucy. "I will not say one word more than is necessary, nor make one allusion or quotation. I will be like your own dear Menelaus: I'll say no more than just the thing I ought."

"Now, papa, will you ask Lucy to explain to you what she knows of the principle of the steam-engine," said Harry, walking up with her to the tea-table, with a composed countenance.

"First, Harry," said his father, "I must ask your mother to read this letter for me, and I have a great deal to say to her about it."

Harry sat down with a resigned look, and swallowed tea, and ate bread and butter, without hearing one word of what was going on, till at last his father turned to Lucy, and said, "Now, my dear, I am ready for you and the steam-engine."

Lucy, who had been listening to the letter, declared she was afraid that the whole of the steam-engine had gone out of her head.

In astonishment Harry stared at her, and, in a tone of indignation, exclaimed, "Is it possible, Lucy?"

"Stay, do not frighten me," said Lucy, "and perhaps I may get it back again."

She did, and she recollected all Harry had said to her; she distinctly said "no more than just the thing she ought." Her father was doubly pleased by the clearness with which she made her explanation, because it showed that Harry had understood well what had been taught him.

"I promise you both," said he, "that, the first time I have an opportunity, I will show you a steam-engine."

Harry was delighted with this promise, and Lucy clapped her hands, and added, "I know, Harry, that the opportunity will come soon."

Harry was going to ask her how she knew this; but his attention was taken off by his father's observing to him that he had done well to refrain from describing to his sister any of the lesser parts of the machinery.

Lucy said, "It was not at all difficult to me, papa, for he brought me up to the steam-engine by degrees, and I was quite surprised when I found I was at it. I did not know what he was about when he began with your cold plate, and the tea-urn, and the expansive force of the steam, and the condensing the water; but I saw plainly afterward, when I found out where I was. It was just like his way of leading me blindfold on the gravel-walk, and taking me to this place and that; and I do not know where I am, or where he is leading me, till he takes the bandage off my eyes, then I am quite surprised at what I see before me."

"Ha! ha! Lucy, I thought you could not get through without an allusion," said Harry. But he was well enough pleased with this. His spirits were so much raised by this commendation, and by the promise of seeing a steam-engine, and a steamboat, and by Lucy's success and his own, that he could not refrain from say-

ing a little more than just the thing he ought. He would now go on to tell her the names of the first, second, third, and fourth inventors and improvers of the steam-engine. But he was fortunately stopped by his father's getting up to look for a book, in which, he said, he could find a poetic description of the wonders performed by the expansive force of steam.

"Oh, I know that book," said Lucy; "it is the same, Harry, in which there are the lines on the barometer and airpump."

"The description of the steam-engine," said their father, "begins by doing honour due to him who

"'Bade with cold streams the quick expansion stop,
And sunk the immense of vapour to a drop.'

Who was that, Lucy?"

"The inventor of the steam-engine, the man who first thought of throwing cold water upon it to condense the steam," said Lucy.

"Savary, or the Marquis of Worcester, I do not know which," said Harry. "You know, father, there have been many disputes for the honour of this great invention."

"Yes, but let these rest for the present, Harry," said his father. "Savary is the person alluded to in these lines."

"Do go on reading, papa," said Lucy. "I like those lines so much."

Her father continued:—

"'Pressed by the ponderous air, the piston falls,
Resistless sliding through its iron walls,
Quick moves the balanced beam, of giant birth,
Wields its large limbs, and, nodding, shakes the earth;
The giant power, from earth's remotest caves,
Lifts with strong arm her dark, reluctant waves,
Each caverned rock and hidden depth explores,
Drags her dark coals, and digs her shining ores.'"

"Yes, I understand," said Lucy; "that describes the steam-engine, bringing up water from the bottom of mines, and dragging the coal-wagons, as Harry told me it could."

Her father went on reading:—

"'Next in close cells of ribbed oak confined,
Gale after gale he crowds the struggling wind,
Th' imprisoned storms through brazen nostrils roar,
Fan the white flame, and fuse the sparkling ore.'"

"The great bellows in forges and foundries, which are moved by the steam-engine," said Harry. "I never should have thought they could have roared so well in poetry. Pray go on, papa."

"'Here high in air the rising steam he pours
To clay-built cisterns, and to lead-lined towers;
Fresh through a thousand pipes the waves distils,
And thirsty cities drink th' exuberant rills;
These the vast millstone, with inebriate whirl,
On trembling floors his forceful fingers twirl,
Whose flinty teeth the golden harvests grind,
Feast without blood, and nourish human-kind.'"

"Do you understand, Lucy?" said Harry. "I forget, my dear, whether I told you, that the steam-engine keeps cornmills and all sorts of mills going."

Lucy nodded. "Do not let us interrupt papa; I will tell when I do not understand," said Lucy, "but I understand all as far as he has gone."

"'Now his hard hands on Mona's rifted crest,
Bosomed in rock, her azure ores arrest;
With iron lips the rapid rollers seize
The lengthening bars, in their expansion squeeze;
Descending screws, with ponderous fly-wheels wound
The tawny plates, the new medallions round,
Hard dies of steel the cupreous circles cramp,
And with quick fall his massy hammers stamp
The harp, the lily, and the lion join,
And George and Britain guard the sterling coin.'"

"Lucy, I am sure you cannot understand this," said Harry.

"No, I was just going to say so, Harry; I waited only till papa came to a full stop. But I know that Mona means Anglesea."

Her father said that she was right; that the azure ores allude to copper mines in the Isle of Anglesea, or Mona, which are worked by the steam-engine. *Cupreous* means *of copper*, and the ores of copper being bluish, the poet calls them "Mona's azure ores." The succeeding lines describe machinery for coining copper, first rolling out thick bars of it into plates, thin as halfpence, then cutting those plates into circular forms, and stamping them with the arms of Ireland, France, and England, the harp, the lily, and the lion. All which is done by machinery, without the hands of men, and that

machinery is kept at work by the motion and power of a steam-engine.

Harry looked triumphant while his father spoke of these wonders performed by steam. Lucy could not conceive how it could do all this. Her father repeated his promise, that whenever he had an opportunity he would show her how it is done; and Lucy whispered again to Harry, "Very soon, too, perhaps."

"Is there no more, father? Is there nothing about the steamboat?" asked Harry.

"There is," said his father; "and it is curious that these lines were written several years before steamboats had been brought into use; and at a time when it was scarcely believed by any but a few courageously ingenious persons, that the steam-engine could ever be successfully or safely employed in driving forward vessels on the water. This prophecy, at the time it was made, most people thought merely poetical; and instead of expecting that it would be *soon* accomplished, it was thought that it would never be effected:—

"'Soon shall thy arm, unconquered steam! afar
Drag the slow barge, or drive the rapid car.'"

"The *slow* barge now goes as fast as you please," said Harry. "The rapid car is to come; and I dare say that will be accomplished soon, papa, do not you think it will? And oh, father, read this; here is something about a flying chariot which we did not hear:—

"'Or on wide-waving winds expanded bear
The flying chariot through the fields of air.'"

His father had purposely omitted to read these, and prudently declined giving his opinion.

Harry became silent and thoughtful for some minutes, but occupied himself with burning a lump of sugar, whose amber drops, as fast as they fell and cooled, he put into Lucy's mouth. And when the sugar basin was taken from him, he found new recreation for his fingers and thoughts in his mother's tambour needle, which he pushed and pulled up and down, through silk and through paper, till she took that from his hand, and then he had no resource but to lean with both his elbows on her frame, and to watch her plying the needle. Lucy whispered from time to time—

"Will not you come and play at '*Travellers*' with me?"

But in vain she twitched his elbow, it remained fixed.

"My mother's work is like a chain," said Harry; "link within link—loop within loop."

"Yes," said Lucy, "it is called chain-stitch."

He watched the lengthening chain, which, with the quick noise of successful pricks, advanced towards him, forming a line from one end of the frame to the other, which was accomplished in two minutes, counted by the watch. Then scallops and leaves, pointed and round, grew under her hand. Nothing too difficult for the dexterous hooked needle.

"It goes on so easily," said Harry, "it seems to do it of itself."

"And do you think you could do it, Harry, as mamma does? Mamma, pray let him have the needle and try."

Harry had little doubt that he should succeed, if he might be allowed to try, because he had most carefully observed all his mother did; he had watched her hand under the frame, and had seen, as he said, how, by a little quick motion, she hung the cotton or silk, whichever it was, over the hook of the needle, and then pulled both up together through the muslin, exactly through the middle of the last link, and then dragged on a new loop, with a little twitch and twist; and down again with the needle.

"Well observed, and accurately described, I grant," said his mother; "you are perfect in the theory, but now for the practice."

She put the tambour-needle into his hand, the feeling of which he liked particularly, because its ivory handle was as large as a pencil-case, and something fit for a man to hold.

"Now we shall see how the man will work tambour-work," said Lucy. "Ay, down goes the needle, pop through the muslin, easily enough; but now get it up again, and the silk with it, if you please and can."

Harry turned the ivory handle to this side and to that, and leaned it this way and that way, and twisted and double-twisted the silk on the hook beneath; and twitched, and plucked, and pulled in vain, and came to "Pooh!" and "Pshaw!" and "Do not look at me, pray. I cannot do it if you look at me."

"Nor if we do not look at you," said Lucy.

"I have done it!" said he, dragging up the needle by

main force, and making a hole in the muslin through which he hauled it.

"Oh, Harry! what a hole!"

"I do not know how it happened," said Harry, "but the needle is up at any rate, and the loop with it; and I have one link of the chain, what you call one stitch and now for the next, which you see I will do better."

He tried again, but the hole made it impossible; he pulled out his first, his only stitch, and tried again in a fresh corner. Nothing ever did try his patience, or, as he thought, nothing ever did try human patience so much. But, by taking thought, he did get the needle and the loop safe through this time without tearing the muslin. He persevered, and in a quarter of an hour had really worked a quarter of an inch of chain, all crooked, dragged out, short and long links of various sizes. Sad chain-stitch, as Lucy called it, but still she could not deny that he had done it. His fingers were so hot that he spread them out to cool, and groaned, and took breath, as his father said a coal-porter might do, after setting down the heaviest load.

His father next took the needle in hand, with a theory as perfect, with somewhat more diffidence, but with little better success. There was a knack in it, which could be learned only by practice. But the gentlemen talked very learnedly to each other about it, and agreed that their perfect theory had helped, would help, or should have helped them, very much.

"But how wonderfully quickly my mother does it," said Harry. "Do it again, mamma, pray. How can you go on so quickly with the work?"

"You think I go on quickly," said his mother, "but all that I could do in a day could be done by a machine, Harry, in an hour. And by what machine, do you think? By your dear steam-engine! This is a use for it of which you never thought."

"Is it possible?" cried Harry.

"Can these *ins* and *outs*, and all this delicate work, and these pointed leaves, be all done by a steam-engine?" said Lucy.

"A huge steam-engine!" said Harry.

"Mamma, how I should like to see it at work, doing the tambour-work," said Lucy.

"Perhaps I shall be able to show it to you, my dear," said their father.

"And soon," whispered Lucy to her brother.

"What can you mean?" said Harry. "I heard you say, *and soon*, over and over again."

"My dear, did not you hear the letter, and all papa and mamma were saying about it?" said Lucy.

"Not I," said Harry.

"You were sitting at the tea-table all the time, beside me," said Lucy.

"Very likely," said Harry; "I did not hear a word that was said."

"What could you be thinking of?" said Lucy.

"I do not know," answered Harry. "Of a bell-crank, I believe. When I saw mamma pull the bell-cord, I thought I would show you the bell-crank in the passage to-morrow, and explain by that the crank motion in the steam-engine."

"How full your head must be of this steam-engine," said Lucy.

"And of you, Lucy, my dear; I was thinking of something to show to you."

"Thank you," said Lucy; "then I will now tell you all that I heard, that you did not hear. The letter was papa's answer to Sir Something Somebody, the man, the gentleman, husband to the lady who told of the shipwreck, when she called here the morning that I spotted my gown with the dirty water from the pump and pond."

"But never mind that now," said Harry; "get on, my dear, I want to hear what is to come."

"Papa's letter was to thank that gentleman for the trouble he has taken in looking for a house somewhere, a great way off, by the seashore."

"And why did papa thank him for that?" said Harry.

"My dear Harry, you are so slow in understanding," said Lucy. "The house is to be for papa and mamma; and if there is but room enough in it for us, we are to go with them."

"You do not say so," cried Harry, starting upright with joy.

"I do say so. I heard it with these ears, and very good ears they are," said Lucy; "and papa told me I might hear. His letter said, towards the end of it, 'I hope there may be two little rooms for Harry and Lucy, their mother and I wish to have them with us.'"

"How kind! Oh! any sort of little rooms—any little

dens would do," said Harry. "I could sleep in a drawer —in a nutshell! Could not you, Lucy?"

"To be sure," said Lucy. "But if they cannot in any way find room for us, we are to be left with my uncle."

"Oh!" cried Harry, uttering something like a groan, "I hope we shall not be left with my uncle, though in general I like to be with him very much; but I never went a journey, a long journey, and with papa and mamma! Lucy, think how delightful it would be! to see mountains, and go up them with my portable barometer."

"And to be by the seaside," said Lucy. "I never saw the sea, and I shall pick up shells by the seashore —beautiful shells and seaweed, and sea-urchins; and we shall live in a cottage. Oh! think of living in a cottage!"

"And we shall see a steamboat, and a steam-engine," cried Harry; "now I understand it all. But remember, it is not certain yet that we are to go, Lucy. I will not think of it any more, lest we should be disappointed at last."

"Joy! joy! joy! for you, Harry; joy for both of us!" cried Lucy. "The great black trunk, and the little black trunk, and the seat-boxes, and the carpet-bag, are coming down from the garret to mamma's dressing-room. Packing up is beginning, and we are to go."

"We! But are you certain, Lucy? How do you know?" said Harry; "I should not like to be disappointed, my dear."

"Who would?" said Lucy. "But no danger, my dear Harry; I heard the answer to papa's letter, and it says that there is room for us. Only, that one of us must be put in a very little closet, which can just hold a bed and a chair."

"I do not care how small it is if I can but be crammed into it," cried Harry.

"Nor do I," said Lucy; "I can sleep on a sofa, or anywhere, so that we may both go."

"If we do not both go there will be no joy," said Harry.

"But I tell you we shall both go. Mamma says she can manage it. They are to set out the day after to-morrow, at six o'clock in the morning. And I asked mamma," continued Lucy, "if I might pack up your things and mine to-day, in the little black trunk. She says I may if I can; only she is afraid I cannot do it well enough; but I think I can. Bring me directly, Harry, to the dressing-room, all the things you want to take with you, and I will get all mine in a minute."

Presently two great heaps appeared on the dressing-room floor.

"There are all my goods," said Harry, pointing to one heap. "All these must go."

"And here are mine; I hope they will all go in," said Lucy, looking doubtfully at the little black trunk which stood between them.

Harry, pressing his hand down on Lucy's heap, observed, that "they could be squeezed almost to nothing. Cram my things in any way," said he, "I do not care how, so that they go—only make haste—I will go and finish my Latin lessons, and be back by the time you are ready to lock the trunk. Ram my things any way, my dear," repeated he, as he left the room.

"Mamma is to see how the trunk is packed when it is finished," said Lucy, "and I must do it well."

She packed, and packed, and squeezed, and crammed, and rammed, but in vain; she could not get in above half of these things.

Then she took out of the trunk all she had put in, and by her mother's advice began to sort her brother's and her own into two classes, of *necessaries* and *unnecessaries*. By this operation her brother's heap was diminished above two thirds, and her own nearly half. When Harry returned, he was not at all contented with her arrangement; and, to satisfy him, she gave up several of her books, and reduced her portion to exactly the same size as his. Harry left her to pack the trunk; and this time, having listened to her mother's advice, to lay each thing, as she put it in, as flat as possible, and to leave no holes or hollows, she succeeded in putting in all things necessary. There was one luxury of her own which she much desired to carry. It was a pasteboard tray, that was made for holding shells. She emptied out all its contents, that she might fill it with a new collection from the seashore. To her great satisfaction,

there appeared just room for it at the top, in the arched lid of the trunk.

Her mother was called to see how easily it locked; and she examined the packing, and pronounced that it was as well done as could be expected from so young a packer. She ran to report her success to Harry, and to summon him to see how nicely her shell-tray lay at the top of all the things, fitting under the arched roof of the trunk. She met him coming up stairs with a huge book, as she thought, under his arm; he asked eagerly if she had finished packing the trunk.

"Quite finished," said she; "come and look at it, and you shall lock it yourself."

Harry looked disappointed, and said that he was very sorry the trunk was quite full, because he had found something else to put in, which he wished particularly to carry with him, and his father had just told him that it must not go loose in the carriage.

"What is it?" said Lucy; "fetch it; if it is not very large, perhaps I can squeeze it in."

Harry, half ashamed to ask the question, said, "Could you get in what I have here under my arm?"

"This immense quarto book, Harry! Impossible!" cried Lucy. "It is as large as half the whole trunk."

"It is only a false book, my dear," said Harry.

"False or true, that does not make it less," said Lucy.

"But, as it opens," said Harry, "and has an almost empty inside, it will hold a great quantity. It will take up scarcely any room in the trunk, only the thickness of its own sides, and they are of very thin wood covered with paper. Do, my dear Lucy, try if you can get it in. It is a camera-obscura, which my uncle has just given to me."

"Indeed!" said Lucy. "Well, my dear, I will try my very best."

But, on opening the false book, she observed that it was not nearly empty; that there was some apparatus withinside of it, which took up a great deal of room. She saw especially a glass, which she was afraid would be broken if she put any thing withinside. He urged her, however, to try. If it were packed with soft things, such as her frocks, all would be safe. "If we can but carry the camera-obscura with us," said he, "when we get to any pretty country, and to the cottage by the sea-side, we shall see such beautiful landscapes in it, and

the boats and ships sailing. Oh! do, Lucy, contrive to carry it."

"I will give up my shell-tray," cried Lucy, "and then I can make room for it perhaps."

"There is a dear good girl," said Harry.

She ran, and he followed her to the trunk. He saw how nicely the tray fitted, and he saw her take it out and put it quite away; he heard a little sigh as she locked the closet door upon it, after putting it out of sight.

"My dear Lucy," said he, "I cannot bear that you should give up your tray; I dare say you wish to carry that and your shells, as much as I wish for my camera-obscura."

"Never mind," said Lucy.

"But I do mind, and the more because you do not," said Harry.

"But I will tell you why you need not care so much, Harry," said Lucy; "I can make another tray of pasteboard easily when we get to our journey's end, and that will be time enough for my shells at the seashore; but you, Harry, could not make a camera-obscura."

"Very true," said Harry; "thank you. But you have all to unpack which you have packed so neatly."

"Never mind," repeated Lucy, "if I can but get it in."

"You need not unpack to the bottom; stop, my dear," said Harry. "The camera-obscura is only about one third of the depth of the trunk."

In it went, and there was a little space at its ends and beyond its breadth, into which things could be crammed, and should be crammed, as Harry observed, to keep it tight. The greatest trial of Lucy's patience was his standing by all the time she was repacking, advising all the while, and saying, as she put in each thing, "That will not go there," or "This would fit better," &c. After she had, to the best of her skill, repacked the trunk, there remained on the floor a new jacket and trousers of Harry's. The jacket, too, was covered in front with innumerable hard, sugarloaf-shaped buttons, which took up a terrible quantity of room, and which could not be compressed. Harry would have found an easy remedy, by leaving jacket and trousers and all behind. He thought he could do perfectly well without them. So did not his mother; upon appeal to her, she decided that they must go. What was to be done? Harry, though

it would give Lucy a great deal of trouble, thought he saw how it could be managed.

"I do not mind the trouble," said Lucy, "if I can succeed at last; but I think it is really downright impossible to get more into that trunk without breaking the hinges in squeezing it down."

Harry suggested, that if Lucy would unpack the whole trunk, and put the camera-obscura at the bottom, perhaps she could get in more; because his jacket, with its hard buttons, might then lie at the top, as her tray had lain, under the curve of the top of the trunk; by having the flat box uppermost, some of that space he thought was lost.

Lucy was not quite clear that he was right; but, however, she, in a most obliging manner, began to unpack the trunk again, and said she would try it *his way*.

All, of any age, who have a good opinion of their own powers of packing, and who has not? will give Lucy more credit for this than for all the rest. She gave up her own opinion, and repacked upon her brother's suggestion with as much zeal and alacrity as if it had been an idea of her own. We are happy to state that this time she succeeded in putting in what was required, camera-obscura, jacket, trousers, and all, to Harry's joy and admiration.

Her mother was pleased.

"My dear little girl," said she, "I am glad to see, not only that you are good-natured to your brother, of that I did not doubt, but I am glad to perceive that you are good-humoured too. Good temper is necessary, even to the most good-natured people. I have often seen good-natured people more ready to make great sacrifices than little ones for their friends; but the little ones are most frequently wanted, especially from women, almost every day of their lives. And if they make these in a good-humoured, obliging manner, as you, Lucy, did just now, they will be beloved, and, as far as they can, will make the friends they live with happy."

"Yes, mamma," said Lucy, "as you do. You came into my head when I was unpacking the trunk for Harry. I recollected your unpacking the great trunk one night at Coventry, when the maid was out, and you were tired to death; and aunt Pierrepoint wanted something which she said was at the bottom of the trunk: and it was not there after all. Mamma, I recollect an-

other thing: one day, when you gave up going to Warwick Castle, which I know you wished very much to see. Well, mamma, on this journey which we are going to take, you shall see, that if I have any trials, I will be as good—I mean in proportion," said Lucy.

Harry at this moment returned to the room, with their hygrometer and its register in his hand; he told Lucy that he thought it would be useless for them to keep the register while they were travelling, as they should change every day to different parts of England, and it was a register of the weather in one place that was required. Lucy was glad he had found out that it would be useless: she was sure that it would have been impossible for them to keep it while on their journey; and she felt relieved from a great responsibility when Harry determined to leave it with their uncle till their return. Lucy further observed, that it would also be impossible, she feared, to go on regularly with Harry in his course of scientific lessons, for which she was really sorry, though the pleasures of travelling, she acknowledged, might make up for this interruption.

"Yes," said Harry, "that is true; we must give up our regular lessons till we come back; but, as papa has just been telling me, it will do us both a great deal of good, and me in particular, to see new things."

"Delightful!" said Lucy; "and thank you, papa, and thank you, mamma, for thinking of such a pleasant way of doing us good."

At six o'clock in the morning, Harry and Lucy were seated opposite to their father and mother in an open carriage; bags, books, parcels, nicely packed in, and Harry's portable barometer snug beside him. "Drive on."

The young travellers stood holding *by something*, no doubt, according to the ever-repeated and never-to-be-too-often-repeated counsel. They looked from side to side as they passed, bidding good-by to each well known object, half sorry to leave home, yet glad to go on to something new. It was a fine morning, the sun shining, the air fresh, and

> "——— Herb, tree, fruit, and flower,
> Glistering with dew."

Their way led through a lane, the hedges on each side full of honeysuckles, with white and pink bind-weed straggling above, about, and underneath. The ground under the hedges was covered with wild flowers of many colours; abundance of that most delicate weed, if weed it should be called, which paints the banks with blue, well known to all the world by one name or other; to the unlearned as speedwell, to the learned as *veronica chamædrys;* there was also abundance of that erect plant, with its spire of crimson bells, spotted or plain, by peasants *foxglove*, by botanists *digitalis* called, valued by the old as a cure for the dropsy, and loved by the young for the loud pop! pop! pop! which in skilful hands can be made by its flowers. Harry asked Lucy if she knew why the foxglove is called digitalis.

"No," said Lucy, "why?"

"Because *digitale* is the Latin for a finger of a glove," said Harry.

"And the shape of these bells is very like the finger of a glove," said Lucy; "but why *fox*glove? foxes do not wear gloves."

Their father said that perhaps it might have been called so from growing in the haunts of foxes.

When they came to the end of the lane, and the road opened to the view of freshly-mown meadows, and extensive cornfields, Lucy exclaimed.

"Look! Look! Harry, at the gossamer glittering in the sun, all over that field, as far as we can see. Do you see it waving up and down with every breath of wind. Pray, mamma, look at this immense cobweb net, all spangled with dew. Is it not beautiful, most beautiful, Harry?"

Harry answered, "Yes;" but it was a yes uttered in a cold tone, which did not satisfy Lucy. Yet he looked at the gossamer earnestly. But he was always more curious about the causes of whatever he saw, than pleased by their appearance. While Lucy had been admiring the glittering, floating, waving net, Harry had been considering how, or by what, this net was made. Lucy said, that in her favourite book of insects,* and in other books, she had read something about gossamer. He begged she would tell him all she knew of it directly.

And as fast as she could she told him, that all these

* Dialogues on Entomology. Rees's Cyclopædia.

shining threads are made by a very small insect, the garden spider, which, like other spiders, can throw out from its body a sort of glutinous substance, which hardens in the air. Some say that the spider leaves the threads behind him, as he darts through the air in search of food. Others say that he has the power of throwing it out before him, and that it catches upon the blades of grass, or on the rough edges of leaves and bushes, and then being pulled tight by the animal, forms as it were a bridge or road in the air, for him to pass from place to place. He has been called by some people the flying spider, and the threads are called air threads, and sometimes these are seen floating over head, and sometimes they are borne down by the weight of the dew, and then caught on the bushes. Harry asked if Lucy ever saw the spider throw out or leave behind him these air threads?

She had not seen it herself, but she remembered that one man in particular, who wrote about the flying spider, declared that he one day *saw* him throw out from his body this substance, and saw him afterward mount and ride away upon it.

Exact Harry was preparing the question whether the flying spider flew, or crept, or rode, walked or darted upon the gossamer, or whether he moved of his own free-will, or was blown or borne away by the wind. But Lucy, too quick for his questions, hastened to tell him something more that she had read of another insect, called the silk spider, which spins silk that is almost as fine, some say finer, than that of the silk-worm. A pair of stockings were actually made of the spider-silk. They were presented, as Lucy assured him, to the French Academy of Sciences, and were much admired. Harry's attention became more respectful when he heard of the Academy of Sciences.

"I was thinking," said he, "that great use might be made of all that gossamer, if it could be spun and woven."

"That has been thought of often," said Lucy; "people, at the time the stockings were made, hoped that the spider would do as well as the silkworm; and they set the spiders at work in paper cases made on purpose; but after they had been kept many months spinning in their paper cells, their work was measured, and it was found that nearly three hundred of the hardest work-

ing spiders cannot produce as much silk in the same time as one good active silkworm."

Still Harry contended, that since there are so many spiders, the great numbers might make up for the little they do; and as we have them always ready, how much better it would be to set them properly to work, than to brush them and their cobwebs away, or to crush them to death.

To this Lucy replied that the common house spider, which is or ought to be brushed away, is not the silk-spinner; that the silk-spinners were not as common as Harry imagined. "Besides, many faults," continued she, "are found with their way of working; they break their threads, or spin them only in short pieces, so that their silk cannot be wound, it can only be spun, and the reeling takes off its lustre. This want of lustre was complained of in the famous pair of spider-silk stockings presented to the French Academy. On the contrary, the silkworm spins her silk without breaking; she winds it round and round into cocoons, which can be easily unwound by a careful person. What length, Harry, do you think the silkworm can spin without breaking?"

Harry was no judge of spinning; but, since he must guess, he would say about as long as the field over which the gossamer spread—perhaps about a quarter of a mile.

He did not think it possible, but he said it on purpose to guess something provokingly beyond what he supposed any silkworm could do.

"A quarter of a mile!" repeated Lucy; "that is a good large guess; but you must know that a silkworm can spin without breaking as much as, when unwound, is six miles long! and, if she is not lazy, can do this in nine days! Believe it or not, Harry, as you please; but I assure you it is true. And what spider ever did as much?"

Harry looked as if he wished to urge something more in favour of the spiders, but had nothing else to say, except that still he did not doubt that some way would be invented of making them useful.

"Oh! my dear," exclaimed Lucy, "I forget my very best argument; spiders can never work together, like good silkworms, because they quarrel and fight, and eat up one another. My insect-book says, that, of I do not

know how many, above forty or fifty, that were shut up together in one room, with plenty of flies and pith of quills, and all the deliccies they like, only two of them were, at the end of some days, found alive; and you know it would be impossible to give each of them a separate house; so there is an end of the matter."

"An end of the matter indeed!" said Harry; "I should never have thought of having any thing to do with them, if you had told me at first that they eat one another. Well, Lucy," continued Harry, "thanks to you and your insect-books, we have had a great deal of diversion out of that field of gossamer."

"I feel much more pleasure in looking at things," said Lucy, "when I know something about them, even if it is ever so little."

"And then there is the hope of *the grand thing* that we are to see by-and-by," said Harry. "Papa, when do you think we shall see a steam-engine?"

"Very soon, my dear," said his father. "We are now in Lancashire, where there are many manufactories, in which the machinery is worked by steam-engines. I hope, that in the town in which we are going to breakfast, I shall be able to show you the grand thing, as you call it, Harry."

"To-day! this morning!" exclaimed Lucy.

Harry, in grave delight, rose from his seat to return his very best thanks; and, in an uncommonly emphatic tone, began with—

"I am *very* much obliged to you *indeed*, father."

But while he was pronouncing this in his sober manner, a branch of a tree under which they were going caught his hat, and carried it off. A little thing could make Lucy laugh before breakfast, when she was weak and hungry; and long after the hat had been regained and replaced, and after the accident was forgotten by their father and mother, who were quietly reading, Lucy shook with unextinguishable laughter, even till they came in sight of the town where they were to breakfast.

After breakfast they walked with their father and mother through the town, to the place where they were to see a steam-engine. A variety of objects caught Lucy's attention as they walked through the busy streets; but Harry was so intent upon what he expected to see at the end of his walk, that he did not look either to the right or the left as he passed.

Much as his expectations had been raised, he was not disappointed when he came to the reality. The ease and silence with which the huge beam of the steam-engine moved up and down, struck him with admiration, and he stood for some time satisfied with watching its uniform motion. Next, he enjoyed the pleasure of recognising each part of the great machinery that he had seen in the engravings which he had studied, and of which he had understood the descriptions.

Lucy could not immediately comprehend what she saw; and she could not extend her ideas from the small scale of the engravings to the great size of the machine which she now beheld. Another difficulty occurred: she could not at one view take in all the parts: she did not know where to look for the boiler and the cylinder, and all the innumerable small pipes puzzled her. However, with her father's assistance, she by degrees made out the principal parts, as they were seen in different stages of the building, for all could not be seen at once.

Good-natured Harry delayed to gratify his own curiosity till Lucy was quite clear in every thing she wished to understand: then he began to question his father. He wanted to know what work this steam-engine was doing. He heard some sounds, like the working of machinery, and he wished to see what was doing. The guide who had admitted them now threw open a door, and they saw a very large apartment, full of whirling, whirring machinery, rows of spindles full of cotton, like the spindles of a spinning-wheel, standing upright in frames, which reached nearly across the room. Each spindle being supplied by a long line of untwisted cotton, from spools or bobbins above. Between each row stood a woman or child, watching the work, and keeping the machinery clean.

"This is one of Arkwright's cotton-mills," said the guide. "All this machinery is kept at work by this steam-engine; and two other rooms full of cotton-frames, which you may see if you please, above and below stairs."

Lucy uttered an exclamation of surprise. Harry was silent with admiration. Turning back towards the steam-engine, he looked about to find where and how the motion was communicated from the engine to the spinning machinery. His father, who guessed what he was looking for, showed him where the shaft was carried through the wall.

Harry had once seen a cotton-manufactory, long ago; but he had only a confused remembrance of whirling spools, and noise, and dust. Here, as he observed, there was scarcely any dust, and but little noise. He was eager to examine and anxious to understand all he saw; but while he was watching them, the quick motion of the spinning spindles suddenly ceased, and, looking back to the steam-engine, he saw the huge beam descending, with a soft, seemingly expiring motion.

"What is the matter?" cried Harry.

"Nothing, master," answered the guide, smiling at his alarm. "Nothing, but that it is our dinner-time. We stop the engine, and all the machines leave off working for an hour, till we come back and set the engine going again."

"And is it possible, that the steam-engine, and all these machines, can be stopped so soon and so easily?" cried Harry.

The man, pleased by the great interest which he saw that Harry felt, showed him how the whole was stopped, by closing the valves of the cylinder, and how the steam was let off after the engine had been stopped.

The women and children were now clearing out of the large room, to go to their dinners, and in a few minutes the apartment was emptied of human creatures, and all was rest and silence. Harry looked blank. He was afraid that he should not see, hear, or learn any thing more; and he told Lucy he thought it very unlucky that they had come at the workmen's hour of dinner. But, on the contrary, this proved a happy circumstance; for their father asked and obtained permission to stay during this quiet hour in the cotton-mill, and he made use of this time to explain it, and to give them some account of the beginning and progress of the invention, and of its improvement.

"Probably all spinning," said he, "was originally done, as it is now in the East, and in some of the southern parts of Europe, by holding in the left hand something like a distaff, with the material to be spun wrapped around it. With the right hand the spinner draws out the fibres of this material, whatever it may be, from the distaff, as in common spinning. It is twisted by a spool or spindle, hanging at the end of the thread, the spool being previously twirled by the finger and thumb. When the motion ceases or diminishes, so as not to

be sufficient to twist the thread, what is spun is wound upon the spool, and the twirling is renewed. This is a simple but tedious mode of spinning. By degrees it was improved, and that ingenious contrivance, the spinning-wheel, such as that with which you are well acquainted, Lucy, was brought into use in England for spinning flax. For spinning wool, you know, a different sort of machine is used."

"Yes," said Lucy, "I recollect the large high wheel, with which I saw a woman spinning wool."

"Now let us go on to the spinning of cotton," said her father, "and the machinery for that purpose. To understand and follow the history of any invention, the first thing necessary is to have a clear idea of what is required to be done, and of the difficulties that are to be conquered. When cotton is taken out of the bale, or large parcel in which it is brought from the Indies, it is generally in hard lumps, sometimes stringy. To prepare it for carding, it is beaten with sticks to loosen it, otherwise it would break or spoil the teeth of the cards. It is then carded, the sole object of which is to separate all the fibres from each other: cards something like those you have seen used in carding common wool are employed for this purpose. The cotton is taken from the card in the form of a roll or *tail*, of about a foot long. Formerly, in the old way of spinning, the next operation was to attach the end of this roll to a wooden spindle, placed horizontally, which could be turned round by a large wheel. The spinner gave the wheel a twirl, and immediately carrying back her hand in which she held the other end of the roll, the cotton was lengthened, suppose from one foot to five—and at the same time it was twisted; the direction in which the hand moved had always a certain inclination to the spindle, so that the thread might slip off, over the end of the spindle, at every revolution. By this means it is twisted."

"Yes," said Lucy, "I understand this; I have seen it in spinning common wool."

"Very well, this is called *long-wheel spinning*," continued her father. "But it occurred to a poor weaver, of the name of Hargrave, that he could improve this method. As but little strength was employed in drawing out the cotton thread, or in turning the spindle which twisted it, he perceived that, if one woman had

ten pair of hands and ten spindles, and could move them at once in the proper direction in drawing out the cotton thread, she could spin ten times as much in the same time."

"Papa," interrupted Lucy, "if the woman had had a hundred spindles, and a hundred hands, like Briareus, she might have spun a hundred times as much."

"Not unless she had known how to use her hundred hands," said her father; "hands without head would do little. But now, without talking of Briareus, how do you think one head contrived to supply the place of many hands? Hargrave's difficulty was to hold fast and draw out many threads at once, keeping them separate, and pulling them evenly, while the spindles were twisting them. To accomplish this purpose he took two slips of wood, and cut their edges so that they could lie close together."

"Like the edges of a parallel ruler," said Lucy.

"Yes," said her father. "And between the edges of these he held fast the ends of the several rolls of cotton wool which were to be drawn out and twisted: the other ends of the rolls, of course, you know, were fastened on the spindles, one on each; and after they had been drawn out and twisted, the motion of the spindles continuing, the thread was wound round upon them. Now suppose the spindles to be set in motion, and that while they are turning he draws his ruler back, then you see each roll of cotton would be drawn out and twisted at once, as if each were spun by a separate hand."

"I see," said Lucy; "at least I understand."

"There are some contrivances necessary in doing this, of which I will not describe to you all the particulars, lest I should puzzle you," added her father.

"Thank you, papa," said Lucy. "But how did the man set the spindles in motion. You said suppose they were turning, but you did not tell us how."

"He placed the spindles perpendicularly, side by side, in a row—eight, I think, he tried at first; and he set them in motion by means of the large wheel, or *long* wheel, as they call it, which his wife used in spinning wool, so that they should all move at once. The wheel had a handle, which was turned by his wife, while the ruler which held the cotton rovings was drawn back, and they were, as he had expected, pulled out and twisted at the same time."

"How happy he must have been," cried Harry, "when he first saw it *do!* When he saw the eight threads drawn out, and the spindles spinning them all at once; how I should like to have been him at that instant!"

"I should like to have been in his wife's place at that instant," said Lucy. "How happy she must have been, and his children, if they were standing by looking at it. So it succeeded perfectly?"

"Not so fast, Lucy, my dear; it succeeded *for* so much, but far from perfectly," said her father. "His first was but a very rude machine, and he had much difficulty in bringing it to a state fit for working. Then he advanced from eight to ten, twenty, eighty spindles, and he improved his machine so that it was brought into common use; and he called it a spinning-jenny."

"A spinning-jenny! Very right!" cried Lucy, "I suppose his wife's name was Jenny. I hope he made a great deal of money, poor man, to support his family."

"I wonder how he came first to think of this invention," said Harry.

"It is said," answered his father, "but I am not sure that it is true, that the first idea of it was suggested to Hargrave by an accident: a number of young people were one day assembled at his house at the hour usually allotted for dinner. They were at play; and they by chance overturned the wheel at which Hargrave's wife was spinning wool. The thread remained in her hand, and the spindle was then perpendicular, and the wheel horizontal. The wheel being prevented by the framework from touching the ground, it continued to turn round with the motion which had been given to it, and kept the spindle in motion. Hargrave's attention was fixed upon it, and it is said that he uttered exclamations of delight, and again and again set the wheel in motion while it lay on the floor, and stood looking at it a long time, the by-standers thinking that he did so only from idleness."

"Ay, but he was not idle," said Harry; "he was at work inventing at that moment; but how did the overturning of the wheel help him?"

"Of that part of the story I am not clear," answered Harry's father. "It is said that Hargrave had made attempts to spin with two spindles, with the common wheel for spinning wool, and that he had tried to use his left hand as well as his right in drawing out the

thread, but that he had always found this attempt ineffectual on account of the horizontal position of the spindles; but when he observed them standing perpendicularly in the overturned wheel, he saw this difficulty obviated, and he thought of so placing his spindles."

"So, then," cried Lucy, "his invention was made by accident, by the lucky accident of the overturning that spinning-wheel. How often, and how many inventions are made by accident!"

"No," said her father; "inventions are never made by accident. To invent is to combine, or put things together for a particular purpose. This, which requires thought, cannot be done by mere chance; though accident may, and often does, suggest the first hint of an invention to an observing mind, or to a mind intent upon accomplishing a particular purpose, and discovers the means that may be used; as in this instance was the case with Hargrave. How many people have seen spinning-wheels overturned without ever inventing a spinning-jenny. But now let me go on to tell you the next improvement that was made in cotton-spinning."

"What! did not the spinning-jennies do it all perfectly?" said Lucy.

"No, no, Lucy," said her father; "you must not be in such a hurry; we cannot come to perfection so soon. The spinning-jennies did only part of what was wanted. The cotton thread spun by the jenny was found to be rough, spongy, and weak. It could be used only for the woof in weaving cotton, the warp could not be made of it. The warp was then made of linen threads, which were strong and smooth."

"From what did this defect in the cotton spun by the spinning-jenny arise?"

"From the fibres of the cotton not being laid smooth and parallel to each other while it was drawn out and twisting. In spinning by hand, Lucy, you recollect seeing the spinner not only draw the thread out, but press and move it at the same time, between her finger and thumb. This smoothed the fibres of the cotton, and kept them parallel with each other. Now this was wanting in the spinning-jenny. The motion of the hand in drawing out the thread was well imitated by the rulers or claaps, which, holding it fast when drawn back, answered the same purpose; but the motion of

the spinner's finger and thumb, and the effect produced by it, were to be supplied."

"How did Hargrave do that?" said Harry.

"He did not do it," answered Harry's father; "it was accomplished by another person, Mr. Arkwright, who, like Hargrave, was originally a poor and illiterate man, but who had the habit of observation and the power of invention."

"Well! how did Arkwright do it," said Harry, eagerly.

"By passing the cotton between rollers," said his father. "By passing it successively between three pair of rollers, placed near each other; the upper roller of each pair is pressed down with different weights. The first pair of rollers through which the cotton is pressed and passed turns slowly, the second faster, and the third more quickly, each with a steady motion. Now suppose, Harry, that the last pair of rollers moved eight times as fast as the first pair, then eight times more length of cotton would pass between that pair of rollers than what had passed between the first pair, consequently the same quantity would be drawn out to eight times the length and eight times the fineness."

"Very ingenious," said Harry. "I wonder how Arkwright came to think of passing the cotton between rollers."

"It is said, Harry," replied his father, "that Arkwright had had frequent opportunities of seeing, in iron works, iron bars drawn out, by being passed between rollers, and he afterward applied this idea to the drawing out of cotton."

"I am surprised he ever thought of it," said Harry; "because the fine fibres of cotton wool and iron bars are so different."

"Still there is some likeness," said Lucy, "in the motion of drawing out the thread thinner and thinner, and smoother and smoother. So you see, Harry, there is good sometimes in observing likenesses."

"What I have said," continued their father, "may give you some idea of the effect of the action of the rollers; I should further tell you, that in the undermost of each pair of rollers were cut fine little grooves or furrows, along the whole of its surface, to roughen it, so as to prevent the cotton from slipping. The upper rollers were covered with leather. The passing the cotton

rovings between these rollers, pressed together as I have described to you, with different weights, and moving with different velocities, had the same effect upon the cotton as that which is produced by the pressure and motion of the spinner's finger and thumb, smoothing down the loose fibres, laying and keeping them parallel with each other, and at the same time drawing them out so as to make a finer thread."

"So at last," said Lucy, "Arkwright did, by the use of rollers, what a woman did at first by the motion of her finger and thumb."

"Yes," said Harry, "but consider how much more was done in the same time, in one day, perhaps, by the rollers, than a woman could do in her whole life spinning. And how difficult and how very ingenious it was, to imitate by machinery that motion of the finger and thumb. And this was Mr. Arkwright's great invention?"

"It was," said his father.

"But what became of the spinning-jennies," said Harry; "were they laid aside when Arkwright made these improvements, and erected these mills?"

"The spinning-jennies are very much laid aside, I believe," said his father, "in consequence of the defects which I mentioned. But for some purposes the cotton they spin is preferable, and for these the jennies are still used."

"Since Arkwright's time have any great improvements been made, father?" said Harry.

"No improvement has been made in the *principle* of his mode of spinning, but many in the simplicity and the perfecting of the machinery. The use of steam and steam-engines, instead of water and water-wheels, for keeping these mills in motion, is in many places of great importance. Of the various improvements in the detail of the machinery I will only mention one to you, an invention made by a Mr. Samuel Crompton."

"That's right," said Harry. "I am glad papa always remembers and tells the name of the inventors."

"Mr. Crompton observed and joined together much that was essentially useful in Hargrave's spinning-jenny and in Arkwright's rollers, or *twist-frame*; and he made a third machine, which combined many of the advantages of the former two, and which is preferred for spinning fine cotton, but is inferior in spinning coarse. This machine is called the *mule*."

"I should like to see the mule," said Harry.

"But you cannot see and understand every thing at once," said his father.

"I hear the workmen coming from dinner," said Lucy.

"Now we shall see this cotton-mill of Arkwright's at work," said Harry.

The guide coming in at this moment, and hearing the last words Harry said, and the name of Arkwright, began to speak of the immense fortune which Sir Richard had made by his inventions and improvements.

"*Sir* Richard!" interrupted Harry, "how did he grow into Sir Richard!"

"The king conferred upon him the honour of knighthood," answered the workman; and he went on speaking of the fine houses and estates Sir Richard Arkwright and his descendants have purchased.

"Did you ever hear, sir," said he, "of the birthday present which Sir Richard's son made to each of his six sons? Each found on his table, on the morning of his birthday, twenty thousand pounds."

"Twenty thousand pounds! Six times twenty," said Lucy, "that is one hundred and twenty thousand pounds! What a sum!"

"And all the consequence of one man's invention," said Harry.

"And industry and perseverance," said his father "Arkwright had great difficulties to struggle with, not only in perfecting his contrivance, but in reducing it to practice, and in establishing his right to the invention."

The workmen were by this time pouring into the room, men, women, and children, and the machinery was set a-going again in a minute or two, and all were busy. Even Lucy, as well as Harry, had some idea of what was doing. They knew the use of the spindles and of the cylinders. Without being perplexed by the smaller parts of the machinery, they had a complete view of each process that the cotton wool undergoes, after it is taken out of its pod, till it is manufactured into the finest cotton.

As they were leaving one of the rooms, the guide showed them a heap of hanks or skeins of cotton yarn, all which, as he told them, had been spun by the mule from a single pound of fine cotton.

"There are here three hundred and fifty hanks," said

he, "and each hank would measure eight hundred and forty yards; and the whole, if stretched out, would make a thread one hundred and sixty-seven miles in length."

"One hundred and sixty-seven miles!" repeated Lucy, "what would your flying spiders say to this, Harry!"

"Or your silkworms, Lucy!" said Harry; "I think your good active best of silkworms never spun more than a silk the length of six miles."

"At any rate," said Lucy, "men and women beat spiders and silkworms both in spinning."

Her father observed that the proper object of comparison between rival spinners is, not the length of the thread, but the fineness. "And I apprehend," said he, "that either a silkworm or a spider's thread is as fine as one fibre of cotton wool; and the finest thread of cotton *must* be composed of many fibres." So that, notwithstanding Lucy's exultation in the superiority of men and women spinners over worms and spiders, Harry was compelled to give judgment in favour of the animals.

"But their superiority is owing only to instinct, and ours to ingenuity and reason, you know, Harry," said Lucy. "It is no merit of theirs that they have their materials prepared for them better than we have."

Here the debate about the spiders and silkworms was interrupted by the entrance of a gentleman who was the principal proprietor of the cotton-manufactory, and the conversation turned upon the prodigious sale of cotton goods and muslins in different parts of the world, especially in England.

"You are aware, madam," said he, turning to Lucy's mother, "that muslins were formerly all made in India; and that it is only thirty or forty years since we first attempted to make them in England, and not till within these few years that we have brought them to their present perfection."

Lucy's mother was well aware of this; she said she remembered, when she was a child, seeing some of the first muslin made in England, and that it was coarse and rough, and looked ill, and wore ill; and that no one then thought English could ever equal Indian muslins. But now it is difficult for the nicest eye to detect the

difference in the appearance and in the wearing; they are as good, if not better.

Harry's father turned to him, and whispered, "If you put me in mind, I will tell you some other time by what ingenious and bold contrivance that roughness in the first English muslin, of which your mother complained, was afterward prevented."

The gentleman continued speaking, and when Harry heard his voice again, he was telling of the immense quantity and value of the muslins now made in England and Scotland.

"All this we owe," said he, "to our using ingenious machinery in these countries, instead of doing all by the labour of men's hands, as in India. Perhaps you are not aware, sir," said he, turning to Harry's father, "of the magnitude of the cotton manufacture. Its machinery earns for England one thousand pounds every working-hour. Forty thousand pounds weight of cotton wool is spun, and in three minutes the length of the thread spun would more than circumscribe the whole earth."

As this was said they were passing through an apartment where Lucy saw a machine for winding the pretty little balls of cotton—she wished to stay to look at it.

"Oh! papa, may I not look at this?"

But her father answered, "No, my dear, you have seen and heard enough—quite enough; if you were to see more, you would confuse what, I hope, is now clear in your heads. Come away."

In the evening Lucy acknowledged that she was rather tired, and was glad to rest, and to stay with her mother, who did not wish to go out again. But Harry, boasting that he was as fresh as ever, was proud to be allowed to accompany his father, who was going to walk out to see the town. After passing through several streets they came to a broad public walk, on a high terrace, shaded with trees, from whence, looking back, they had a fine view of the town by the red light of the setting sun, which beautifully illuminated several windows, especially those of a Gothic church. As Harry was returning through the streets, he regretted that Lucy had not been with them, and he asked his father

whether they were to go away from this town early in the morning, or if he would stay another day; his father, who perhaps was thinking of something else, answered in an absent manner, "I do not know, my dear; that will depend upon circumstances."

Harry was considering, as he trudged on, what could be meant by "that will depend upon circumstances," when, on turning the corner of the street, his thoughts were stopped, and his eyes struck, with a sudden blaze of lights—gas-lights. Harry's admiration lasted in silence the whole length of the street; when, turning into another, still more bright, he exclaimed,

"It is almost as light as day! Father, what kind of lights are these, and of what are they made?"

His father told him that they were called gas-lights, and that they were made of gas obtained from coal.

Harry asked, "How is gas different from other flame of candle or fire?"

His father told him that *all* flame is gas set on fire: "In a common fire, in a candle, or lamp, what you see, and call flame, is gas, which, when set on fire, continues to flame when exposed to the air."

Harry asked, "How is gas *got out* of coal?"

His father told him, "By the coal being strongly heated in iron vessels called retorts, which have but one opening for the gas to escape from into the reservoir where it is preserved."

Harry next inquired how the gas gets from the reservoir to the small pipes, so as to light all the houses in the street, where he saw gas flaming at the windows.

"Suppose a tumbler to be inverted in a basin of water," said his father, "you know, that as there is air within-side of the tumbler, that air will prevent it from sinking in the water."

"Certainly," said Harry.

"But you may put weight upon the tumbler, till you compress the air in the inside, and then the water will first rise to supply the place of the compressed air. And what will happen afterward, Harry?"

"I think nothing would happen, father, but that the water in the basin would continue pressing up the air till it had forced it into the smallest space possible."

"Very true; to the smallest space to which it is possible for the water to compress it; but the air being compressed, its elasticity continually increases, till it not

only resists the pressure of the water, but drives out the water from the tumbler, and raises it in the surrounding basin. Now suppose one end of a small pipe were introduced under the edge of the tumbler, what would happen?"

"The compressed air would be forced into the pipe, to be sure," said Harry.

"And if the pipe were open at the other end?" said his father.

"The air would go out at the other end," said Harry.

"And what would happen to the tumbler?" said his father.

"The tumbler would continue descending till all the air was driven through the pipe," answered Harry.

"It would so. Now, instead of common air, suppose your tumbler filled with gas, exactly the same thing would take place. This is called a gas-holder, and this is the manner in which the gas is continually forced from the reservoir through the pipes."

"I understand it," said Harry; "and I hope you will some time or other show this experiment to Lucy. It would be very easily done with a glass and basin."

"You may show it to her yourself," said his father.

"Does the gas light immediately of itself when it comes into the air?"

"No; when a person wants to light it he holds a candle to it, and it flames as you see in the open air."

"Suppose it was to rain, or suppose the wind blew strong," said Harry, "what would become of these lights? Look at these flaring, without any glass around them, in the open window, in this butcher's shop. Would not they be extinguished?"

"Not by slight rain or wind," said his father. "One great advantage of gas-lights is, that they are not easily extinguished by rain or wind."

Harry's admiration increasing the more he heard of their advantages, and considered their convenience and beautiful brightness, he wondered why people had not thought of using them sooner. And he asked if this gas had never been known to exist till now.

His father told him that it had been long known as what we see in the flame of fire and candles; but that till lately no one had thought of obtaining it in quantities, and bringing it into common use, in the manner in

which he now saw it. "I could tell you, Harry, two curious anecdotes, which I heard from a friend."

"Can you, father?" said Harry. "Then pray do. Will you be so good as to tell them to me now?"

"If you will mind where you are going, and not run into the gutter," said his father.

"About forty years ago, a certain Lord Dundonald had a patent for making what he called *coak* from coal. Coak is half-burnt coal, such as you have seen used in forges; to obtain the coak he half-burnt the coal, and the tar and gas which were in the coal were, by this process, separated. The coak being his only object, the gas was conducted under water many hundred yards, in large tunnels, in order to condense the tar, and the gas escaped out of a high chimney. How it became lighted my friend said he did not know; but once lighted it continued to burn, and the flame illuminated the country for twenty miles round."

"I wish I had seen it," said Harry. "How grand and beautiful it must have looked! But when people saw this, I wonder no one thought directly of making use of the gas, and of obtaining it in the same way for lamps."

"It is the more surprising," said his father, "because it was, in fact, a gas apparatus, like that at present used, only the gas was suffered to escape and waste itself."

"But, father," said Harry, "what was the other anecdote?"

"Long before this Lord Dundonald's time, there was a chymist whose name I do not recollect, who made gas from coal, and stored it in bladders, and frequently amused his friends by pricking a hole in the bladder, and then applying a light to it. This was *portable* gas, such as people are now beginning to use, only in a different case."

"Well, this is more extraordinary still," said Harry; "because that gas in the bladder was in such a convenient form for carrying about; it is wonderful that neither he nor any of his friends who saw it ever thought of making use of it for lamps. I wish I had been by when he showed the bladder and pricked it, and set fire to the gas. Father, even such a boy as I might have thought of it, might not I?"

"You might, Harry," said his father; "but how few men, to say nothing of boys, observe what they see any

day or every day, or think of what use can be made of it!"

"But so striking a thing! and so obvious a use!" said Harry. "What seems so easy and natural now that it is done!"

"True, Harry. The thing was there before their eyes, but useless, because they did not think of making use of it."

"And for forty years and more!" said Harry.

After a long silence, during which Harry stumbled sundry times, he exclaimed,

"Father! I am thinking—"

"Not of where you are going," said his father.

"But I am thinking, father, that there are a great many other little things, which people have not yet observed, that may lead to great things, if people think of putting them to use."

"Undoubtedly," said his father: "in this you are very right."

"And, father, do you think, that if I try to observe and consider what use I could put these things to, I shall ever discover or invent any thing new?"

Harry was here interrupted by stumbling over a walking-stick, with which a man whom they met was feeling his way, and which Harry had not observed.

"I wish that man would not poke out his stick so," said Harry; "it nearly threw me down."

The man begged his pardon—said he was blind, and was forced to grope his way with his stick. Harry now begged his pardon for running against his stick, and guided him across to the next street, and the old man wished him a good night, and said,

"May you never be blind as I am. And whenever you are old, may you meet with help as I have from you."

As soon as the blind man had left them, Harry began to recollect what he was saying when he first met him; and he would have resumed the conversation, but his father told him that he could not talk to him any more now, and that he must walk fast, for it was getting late. Harry trudged on as quickly as he could. His father thought he must be tired, and so he was, but he scorned to complain.

It was late when they reached the inn. Tea had been waiting some time, and Lucy, after struggling to keep herself awake, had fairly given up the point, and had

fallen asleep, her head resting on her arms, which were crossed on the table. She was so fast asleep that she could hardly be wakened sufficiently, when Harry came in, to ask whether he had had a pleasant walk. After swallowing a cup of tea with her eyes half shut, she submissively obeyed the signal of the chambermaid with bedchamber candles, and retired to that rest which she much wanted.

Harry would stay up to listen to a conversation between his father and a postillion, from which he hoped to discover what would be done in the morning, and what was meant by "that will depend upon circumstances." But before he had made this out he fell fast asleep across the great black trunk, where he lay unobserved till the waiter tumbled over his legs, and let fall a spoon upon his head. Harry started up. He had dreamed, as he said, that he had been struck by the beam of a steam-engine. His mother exhorted him to go and dream in bed. She took up a candle to light him on his way; but he turned, and stood looking at the postillion, astonished to see him still standing there, and his father still talking to him.

"Mother! what an immense time this man has been standing talking," said Harry.

"Not above five minutes, my dear," replied his mother.

"Five minutes only!" cried Harry. "I have been in that time all the way to Germany and back again, at a palace magnificently lighted up with flaming crocuses of gas. I asked whose house it was. 'Do not you know?' said the man. 'It is your friend the great Otto Guerick's.' I was not surprised that he was living still. I only said I would go and see him. But the inside of the palace was like a cotton-mill, and there was a great steam-engine going on working away. Through all the workmen, and women, and children, I went on, asking for Otto Guerick, till at last one guide-man said he would show me the way to Otto's laboratory, where he was trying experiments *always*, in his silk nightgown. But the man said the laboratory was at the top of the house, and asked if I could follow him up high ladders. Oh, yes! I said, as high as ever he pleased. So I went scrambling on after him, and if my foot had slipped I should have gone down, down, down, I do not know where; but I reached the top, and a door opened, and I

heard the rustling of Otto Guerick's silk nightgown, and I was just going in when that spoon, which I thought was the beam of a steam-engine, fell upon my head. Oh, mother! I wish it had not fallen. It was so provoking to be wakened at that moment, just when I was going in to see Otto Guerick. I wish that I could dream it over again."

"You had best sleep again, Harry, my dear," said his mother, "and this time sleep in your bed. Come," said she, showing him the way through the passage to his bedroom, where she put into his hands his nightcap, which Lucy, even in the depth of her own sleepiness, had remembered to leave ready for him.

Harry slept nine hours without intermission, but he saw no more of Otto Guerick, or his gas-illuminated mansion. He was still fast asleep when his mother called him. During breakfast his father and mother talked about the various noises they had heard in this inn all night, and by which they had been so much disturbed that they could not sleep. His mother said that a coach had arrived or set out every half hour, that she had heard bells and calls, hostlers and chambermaids, and waiters running to and fro in the passages continually, and people calling perpetually for their trunks, and portmanteaus, and parcels, and bills. Harry's father said that the partition between their room and the next was so thin that they could hear every sound; and there was a man in that room who seemed to be pulling off his boots and throwing them down, and throwing wooden legs after them, all night.

Harry and Lucy looked at each other when their father and mother talked of all these noises; they were surprised, for they had slept so soundly that they had not heard them.

During breakfast, Harry told Lucy that it depended upon circumstances whether they were to go on with their journey to-day, or to stay in this town. Lucy said she was not at all the wiser, as she did not know what circumstances he meant. Their mother told them that it depended upon a letter which his father expected to receive by the post, to tell him whether his friend would return home this day or not. Harry's only reason for wishing to stay was, that Lucy might see the pretty walk he had taken the preceding evening; but as it was now raining, they could not walk, and he was

glad that they were not to spend the day at the inn, where they had nothing to do.

"What shall we see next?" said Lucy, as she got into the carriage. "I like going on to something new."

"If you had your choice, Harry, what would you wish to see next?"

"A mountain," said Harry, who was faithful to his old wish for a mountain to measure with his portable barometer. While he had been taken up with the cotton-manufactory, and the steam-engine, and the gas-lights, this wish had slept in his mind; but it was now awakened with fresh eagerness. As they journeyed on he eyed the outline of every hill on the horizon. But he observed a discreet silence upon the subject. Even when Lucy exclaimed, "Here's a mountain coming for you, Harry!" he replied soberly—"So I see, my dear, but it is not near enough yet; I will speak when I think it is time."

At last, when they came into Derbyshire, and into the hilly parts of that county, Harry spoke, for he thought it was time.

"Father! here are plenty of mountains! will you be so good as to stop the carriage, and to let me get out, that I may measure this one which is almost close to us. I will not detain you above twenty minutes, mother, if you could be so good as to wait—in ten minutes I would run up, in ten minutes I would be down again! May I, father?"

"No, Harry," said his father, "we cannot stop for you now. It would detain us much longer than you imagine. Your eye deceives you in judging of distances and of heights to which it is unaccustomed."

"For your comfort, Harry," added his mother, "we are going to Matlock, a place where you will find yourself surrounded by fine mountains, upon which you may try your own and your barometer's measuring powers at leisure, for we shall stay there two or three days."

"Delightful!" thought Harry, "thank you mother," said he.

Presently they entered a narrow but beautiful valley; a stream ran through it, and there were hills on each side. Their banks were covered to a great height with

trees of the softest foliage, and of various shades of green, tinged here and there with the brown and yellow colours of autumn. Above, high above the young feathery plantations and the scrubby brushwood, rose bare whitish rocks. Sometimes stretching in perpendicular smooth masses; sometimes broken in abrupt craggy summits, huge fragments from which had fallen into the river below. The river flowed tranquil and placid till, when opposed by these massy fragments, it foamed and frothed against their immoveable sides; then, separating, the waters whirled round them in different currents, and joining again, the stream ran on its course, sparkling in the sunshine. The road now lying beside this river, brought them soon to the pretty straggling village of Matlock.

The morning after their arrival, they went out to walk. At a little distance from the hotel, where they lodged, was a walk up Masson-hill. It was a zigzag path, cut through a wood of fir-trees, reaching to the summit, called the Heights of Abraham. They went part of the way up this path, and Harry was eager to go to the very top; but his mother was not able, she said, to go quite to the Heights of Abraham; she, and his father, and Lucy, went to see a cave in this hill; but his father told Harry that he might go on by himself, if he liked it, to the top of Masson-hill, and take its height with his barometer, and compare this with the reputed height, which is said to be about 750 feet.

Harry, to Lucy's surprise, stood hesitating, with his barometer in his hand, instead of going on with the alacrity she expected.

"What is the matter! would you rather come with us to see the cave!" said Lucy.

"No," said Harry, "that is not the thing."

"What then!" said Lucy, "Do you want me to go with you! I should like it, but you know mamma said that I must not go running about everywhere with you here, as I do at home; I must stay with mamma. But you look afraid to go by yourself," added Lucy, laughing.

"Afraid! my dear, I am not the least afraid to go by myself anywhere in the world," said Harry, proudly: "I am not going to do any thing wrong: what should I be afraid of!"

"I do not know," said Lucy, "that is what I want you

to tell me. I am sure there is something you do not like, or else why do not you set off?"

"There is something I do not like," said Harry, "*that* I acknowledge. I do not like to meet those people who are there, farther up on the walk."

"What harm will they do you, Harry?" said his father.

"No harm, father; only I do not like to meet them, because they are strangers."

"But since, as you observed, Harry, you are not going to do any thing wrong, you need not be ashamed—I will not say *afraid*, to meet them!" said his mother.

"That is very true, mother," said Harry; "I know it is very foolish; well, I will conquer it; I will go on by myself," added he, resolutely.

"Go on and prosper then," said his father. "I dare say that those people will never think about you, unless you do something to attract their attention."

Harry walked off as fast as he could; nor stopped till he reached the Heights of Abraham. Then he took out his barometer, and noted down the height at which the mercury stood, both in the barometer and thermometer. Then he went down the hill, and as soon as he had reached the bottom, he looked at the mercury again in each, noting down carefully these heights also. Finding a retired nook away from the public path, he sat down to work at his calculations, resolved not to stir till he had completed them. On his barometer there was engraved a table of the heights at which the mercury stands at different elevations, calculated when the atmosphere is at the freezing point. Besides this, he had taken care to bring with him a certain little book* containing "An expeditious method of calculating altitudes;" the want of which had, in his first attempt to measure the church, prevented his succeeding to his satisfaction. Now understanding and following the directions contained in this little trusty companion to his dear portable barometer, he made his calculations sufficiently accurate to satisfy his conscience. He brought his answer within two feet of the height which his fa-

* "An expeditious method of determining altitudes with the new portable mountain barometer, with a description of that instrument, by Sir Harry Englefield, Bart,"

A little tract which is, or ought to be, sold with every portable barometer.

ther had told him had been determined by previous measurement.

He next went to look for the cave.

It was a large, deep, dark cavern, at the farther end of which he perceived light; and as he advanced he saw the forms of men—of the guides, who held torches, and he heard Lucy's voice, and the voices of his father and mother, and soon distinguished their figures. They were all looking up at the roof, on which the guides, with raised torches, threw a strong light. From the roof, which appeared incrusted all over with yellow earth, hung multitudes of what seemed like earthy icicles, of the same colour, and of enormous bulk.

"My dear Harry! are you there?" cried Lucy; "I am glad you are come; I was so afraid you would not come in time to see these! Are not they beautiful? Do you know what they are? They are stalactites."

"And how came they there?" said Harry; "and what are they? You tell me they are *stalactites*, but that tells me nothing but their name."

"It is a good thing in the first place," said Lucy, "to know the name, because then we can ask people questions, and then they will know what we are talking about." She told him all she had just learned, from what she had heard the guides and her father say; that these stalactites were formed by the water oozing through the roof of the cavern, and depositing, as it trickled down, some calcareous earth, which it had dissolved in its course through the soil and rocks, along and down which it had passed. She believed that these rocks were calcareous, or limestone. She had further heard one of the guides say, that some stalactites found in this country became almost as hard as stones, were of various colours, and had been polished and made into necklaces, and different ornaments. The guides had broken off from the sides of the cave some of the stalactites, and had given pieces of them to Lucy; some of these, which had been newly formed, were softish, and crumbled easily when pressed between the fingers; some were a little harder and crisp, cracking rather than mouldering when pressed; others were as hard, Harry observed, as some petrifactions which he had seen in his uncle's collection. His father told him that those petrifactions had been formed in the same manner in which these stalactites were formed; and the

guides said that they would show him plenty of petrifactions, and crystals, and beautiful spars of different colours, for which Derbyshire is famous.

While all this was saying, Lucy's mother, who did not like standing still long in this damp cavern, had, by gentle degrees, alternately drawing Lucy on by the hand, and urging Harry forward by the shoulder, kept moving onward, till they found themselves again at the entrance or the exit of the cave; they were glad to see the daylight, to feel the fresh warm air, and to tread again on dry ground.

Several boys and girls met them in their way to the hotel, with baskets of crystals, spars, and petrifactions. In one basket Lucy saw a petrified wig. The guides told her that the people of Matlock amuse themselves by putting wigs and different things in these calcareous springs, to have them, as they say, *converted* into stone. Such they seem to turn into, as no appearance of the original substance is left except the form. But, as Harry observed, it is not that the substance turns into stone, but that the calcareous deposition covers it all over, and the original substance in time decaying, nothing afterward is left but calcareous stone. In another basket Lucy saw spars of various colours; some of purple and some of amber, of different shades, in rainbow stripes, or cloud-like streaks. Some of these spars were made into hearts, and necklaces, and boxes, and urns, and eggs, and various trinkets.

Lucy's mother told her that she might choose any one of these things she liked.

Lucy chose a polished egg, of shaded purple spar; it seemed transparent, and looked as if you could see into it to a great depth; but when Lucy tried to open it, she found that it did not open.

"Of what use then can it be?"

It had a little gold ring at the top of it, and was intended to be used as a netting-weight. Lucy had been long making a purse for her father: she was sure that the pleasure of using this pretty weight would encourage her to go on netting it, as soon as ever they should come to the end of their journey. But how was the egg to be carried? Her father said he could not have it rolling about the carriage; and the pockets were already fully occupied. Lucy would have been reduced to take a flat heart instead of her beautiful egg, if Harry—

"good at need"—had not stepped forward, and opening, wide as he could stretch, the mouth of his waistcoat pocket, bid her put her egg in there, "where there is plenty and plenty of room," added he, shrinking in his stomach to show the ample space.

"My dear Harry, you are very good," said Lucy.

"Not the least," said Harry; "I should be very bad if I did not recollect how good you were about my camera-obscura, which you crammed into the trunk. Come, drop your egg in here at once, and say no more about it."

She dropped it into the pocket.

"But, my dear Harry, it looks as if you had a great swelling; people will stare."

"I do not care," said Harry; "let them stare."

This was indeed, as Lucy knew, a great proof of Harry's affection; for in general he disliked excessively to be stared at, and avoided every thing that could bring upon him such a misfortune.

"Besides," added he, patting down the egg in his pocket, "it does not stick out *now* more than my ball, which I have often carried here, and nobody ever noticed it except my mother. Indeed, now I have got it into the corner, you see it is not a greater lump than my pocket-handkerchief, which sticks out as much on the other side, so all's right."

"But if you were to tumble down, the hard egg might hurt you, Harry."

"I might hurt it," said Harry, "for I should break it, I suppose. But, my dear, I never, that is, hardly ever, tumble down; and now I have this egg, it will make me more careful; so say no more about it. Now I want to tell you about the Heights of Abraham."

He had prudently forborne to speak of his operations while her head had been full of stalactites, and spars, and wigs. She now listened to him with due sympathy, and was delighted when he informed her that his barometer measurement came right within two feet. His father congratulated him upon his success, with which he was particularly pleased, because it was the consequence of perseverance. He was glad to see that his son would not be satisfied till he had rectified his errors, and had been as exact as he possibly could. This promised well for his future progress. All the rest was mere child's play. "Very few uncles," said he, "would have given a portable barometer to a boy of your age.

I am glad you can prove to him that you have been able to use his present, and that it has been of service to you, Harry."

"It was lucky for me," said Harry, "that there was nobody by, on those Heights of Abraham, when I was at my work; and lucky too, when I came to the bottom of the hill, that I found a snug place, out of the way of everybody, where I made my calculations, or else I am sure they would have been all wrong."

"That would have been a pity!" said Lucy, "after all your pains."

"Therefore it would be a great advantage to you, Harry," said his father, "if you could learn to calculate, and to be able to go on with whatever you are doing, when people are looking at you, as well as when you are by yourself; because you cannot hope always to be alone when you want to think, nor can you always hope to find snug, solitary places for your calculations. Every common schoolboy is forced to learn his lesson, and to cast up sums, without being disturbed by strangers. All this is easily learned by practice."

"Ay, by practice, I dare say," said Harry.

"And I will tell you what you can do by your own sense," added his father; "upon every opportunity try to conquer your dislike to going among strangers, and then you will get over your bashfulness."

"Father, then, if you please, I will go with you to-day, and dine at the public table, instead of staying with my mother and Lucy."

"Right, my boy, so you shall."

When dinner-time came, Harry went along with his father; and as he walked into the public room, said to himself, "I am doing nothing wrong: I need not be ashamed: I will not be bashful." Still a mist of confusion came before his eyes, when, seated beside his father at a very long table, he saw opposite to him a line of strangers, and on all sides of him strangers! He scarcely ventured to look up at their faces. He was seized with one of his fits of the cramp of bashfulness, under which he sat suffering and stiffened, blushing, and conscious that he was blushing, scarcely able to answer "Yes," or "No, thank you," when he was asked what he would have. He thought that everybody must take him for a fool, and this made him feel more uneasy and awkward. He scarcely saw or knew what he was

doing; he threw down first one thing, then another; first his fork, then his bread in reaching for the fork, then the saltcellar, and at last a glass of water into his father's plate. It was well it was no worse. His father set the glass up again, sent away his plate, and said nothing about it. Harry wished he was in his mother's room, or under the table, or anywhere but where he was. His blunders and disasters had more and more provoked him with himself, and he thought he had disgraced himself for ever, and that people must think he was a vulgar creature, or a child not fit to dine with men or gentlemen, nor used to dine anywhere but in the nursery. His face was by this time all burning with shame, and scarlet up to the roots of his hair.

While he was in this condition, the lady who was sitting beside him asked him if she should help him to some oysters; he happened to dislike oysters, and he answered, "No, thank you," in rather a surly tone; and then, thinking he had done wrong to answer so gruffly, held his plate out, and said, "If you please, ma'am."

"But you have not finished your sweetmeats: I did not observe that," said the lady. "You do not like sweetmeats and oysters together, do you, my dear?"

"I do not care, ma'am, thank you," said Harry.

"You are not the young gentleman, are you," said the lady, "whom I met this morning with a barometer in his hand?"

"I do not remember meeting you, ma'am," said Harry; "but I had a barometer in my hand."

"Really, I should not have thought you were the same. May I ask what you were doing with that barometer?"

"I cannot explain it to you, ma'am, now," said Harry.

A gentleman luckily asked her at this moment to drink a glass of wine, and she turned away from Harry, and thought no more about him or her question. Still his father took no notice of him, but left him to recover himself by degrees, and to find out the truth, that people were thinking of themselves much more than of him. Gradually he came to the use of his senses and understanding, so far as to hear and comprehend something entertaining which a gentleman who sat opposite was relating. As soon as Harry became interested in listening to what this gentleman was saying, he unstiffened, looked up, moved forward on his chair, forgot his blushes

and his blunders, and all his fears of having disgraced himself; in short, he forgot *himself* altogether.

The gentleman was giving an account of the plundering of a vessel which had been stranded on the coast of South Wales, in St. Bride's Bay. It was a transport, laden with ordnance stores from America.

Harry made out that "ordnance stores" here meant gunpowder and guns. Some of the people on the coast saw the signals of distress which were made by the persons on board the vessel; but instead of putting out boats and going to their assistance, these wicked people thought only of plundering the vessel, and carrying away every thing they could for themselves. They assembled on the beach, and waited there till the ship was driven on shore and wrecked. While the poor people on board were trying to save their lives, these plunderers were busy carrying off all they could from the wreck. They boarded her as soon as possible, because they knew that as soon as ever the gentlemen of the country should hear that a vessel had been wrecked, they would come to assist the sufferers, and to prevent the plunder. The mob made such haste, that they got possession of their prey, and landed a considerable quantity of gunpowder from the stranded vessel. Many of the plunderers were loaded with as much as they could carry, while others were struggling for their share of the booty, as their confederates were dragging it on the shore.

In this scene of confusion, and in these struggles, a quantity of the gunpowder was scattered on the shore and on the rocks. One of the ringleaders of the mob quarrelling with another, who had got possession of a musket which he wanted to have for himself, seized it and threw it from him with violence. What happened none could exactly see, as it all passed so quickly; but probably the musket had struck against a flint—a single spark was enough to set fire to the gunpowder which was scattered over the rocks. One explosion after another was heard, one train communicated to another, and in a few seconds the whole strand and rocks seemed wrapped in fire and smoke. Many of the plunderers were killed on the spot; others were dreadfully maimed, and died lingering deaths. The man who threw the musket absconded, and was never heard of afterward.

While Harry listened to this dreadful but true story,

pity for the shipwrecked people who perished for want of timely assistance, indignation against the wretches who thought only of plundering the wreck, wretches such as he could hardly believe to exist, horror at the catastrophe, an awful sense of the justice of the punishment which they immediately brought upon themselves, and satisfaction that they gained nothing by their crime —altogether filled his mind; and these successive sentiments and reflections so absorbed him, that he completely forgot every thing else, forgot where he was, and who was by, and all his own little foolish feelings. What was become of his bashfulness! It was all gone; gone off with that superfluous anxiety which he had felt about the opinions the surrounding people might form of him.

After they left Matlock, the road appeared uninteresting to our travellers. But they had books in the carriage, and Lucy's mother began to read at first to herself, and afterward to her companions, when she found any thing that she thought would entertain them.

"Here is an account," said she, "of the various stinging insects which infest parts of South America, where the inhabitants pass their lives complaining of the insufferable torments of the moschetoes."

"Will you be so good as to read it to us now?" said Lucy; "I am so very comfortably settled with your dressing-box under my feet."

"Persons who have not navigated the great rivers of South America, for instance, the Oroonoko and the Rio Magdelena, can scarcely conceive how, at every instant of life, you may be tormented by insects flying in the air, and how the multitude of these little animals may render vast regions almost uninhabitable. They cover your face and hands, pierce clothes with their long sucker in the form of a needle, get into your mouth and nostrils, and set you coughing and sneezing whenever you attempt to speak in the open air. In the villages on the banks of the Oroonoko, which are surrounded by immense forests, the plague of flies affords an inexhaustible subject of conversation. When two persons meet in the morning, the first questions they address to

each other are, 'How did you find the *zancudoes* during the night? How are we to-day as to *moschetoes*?'*

"At New-Barcelona the wretched inhabitants generally stretch themselves on the ground, and pass the night buried in sand, three or four inches deep, leaving out their heads only, which they cover with handkerchiefs. Farther on, the traveller fares worse, for he comes to the region of the *sorrowful people*, as they are called, who are doomed to be for ever tortured by these insects. One poor monk, who had spent, as he said, his twenty years of moschetoes in that country, desired Humboldt and his companions to tell the people in Europe what the poor monks suffer in the forests of South America. When an inferior monk commits any fault, his superior exiles him to this country, and they call it being condemned to the moschetoes."

Lucy said she was glad she was not condemned to the moschetoes, and she asked her mother if there was any more that was entertaining about them. Her mother read to her an account of the different kinds of stinging insects, which *mount guard* at different hours of the day and night. Just at the time when one party are flying away, and when the next have not fixed, or, as soldiers would say, at the time of *relieving guard*, there is an interval of repose. The different hours of the day and night are marked and known to the inhabitants by the different stinging flies, so that, as they say, they could tell blindfold what hour it is by the sting of the last, or the hum of the coming torment.

"Horrible creatures!" said Lucy, "I am very glad we have none of them in our country."

"Horrible!" repeated Harry, in an absent tone: he seemed to be heartily glad to have this history of the moschetoes finished, and to get rid of them. They had prevented him from fixing his attention upon something which he wanted to think of.

The moment his mother's closing tone announced that she had finished, he threw himself half over his side of the carriage, and began to watch the hind wheel.

"Is there any thing the matter with the wheel, brother?" said Lucy.

"Nothing, my dear, I am only thinking of something."

* Humboldt. Personal Narrative, vol. v.

"Take care, Harry," said his mother, "I think you will fall out."

"No, thank you, mamma, there is no danger of that, I am holding by the holders," said Harry.

There was nothing more to be said about the safety of the position he had chosen; something might, perhaps, have been said about its unsociability, but his mother went on reading, and his father and Lucy were listening to her.

"Oh! Harry!" cried Lucy, "listen to this; here are the termites, the great ants, will not you hear about them!"

"Thank you," said Harry, "I have heard enough about them."

She left him to his wheel for some time, but presently returned again with—

"Oh! Harry, did you hear that about the jaguar, that came bounding to the shore to play with the little girl, and tore the skin of her forehead, and she drove him away with the bough of a tree: only think!—the jaguar!"

"My dear Lucy, you jogged me and put me out in my count. Now I must begin all over again," said Harry.

She drew back, but after some little time exclaimed again—

"Harry! oh! Harry, hear this! a *shirt-tree!* My dear Harry, a real name of a real tree, fifty feet high, shirts ready-made grow upon them without a seam!"

"One hundred and fifty-five! I am very glad of it. One hundred and fifty-seven," said Harry, continuing to count on.

"If the shirt-tree won't do, nothing will," thought Lucy; and she sat down and sat still during many pages; then starting up again, she threw her arm round him.

"Oh! Harry, Harry; the most beautiful story you ever heard. A mother in search of her children, who went through such difficulties, and such places, as no person had ever the courage to go through before! and lived for four days on nothing but black ants, and was stretched upon the rack at last, and tortured. Oh! Harry, won't you listen to the end of it?"

"Two hundred and twenty-one: my dear, another time, you will tell it to me; two hundred and twenty-two."

Lucy gave it up, left him to himself, and listened to the end of the story; sorry, however, that he could not, or would not, enjoy the pleasure with her.

After this story of the Piedra del la Madre, or rock of the mother, was finished, Lucy's mother was tired reading aloud: her father took up a book to read to himself; and Lucy, who had the happy power, either travelling or at home, of being able to amuse herself, began to point out to her mother every thing or animal she saw on the road which she thought would look pretty in drawing.

"Look, mamma, at that woman, who is crossing the field with a basket of hay on her back, and the cow following, without her perceiving it, and eating the hay: is it not like one of the vignettes in Bewick? Mamma, as you are not busy now, whenever I see what I think would be a good Bewick on the road, I will tell you, and you will tell me whether you think it would be pretty or not.

"Look at this old tired soldier stopping beside the well, and the little girl holding up a tin can that she has just filled. Now he is stopping to drink, and she is putting back her hair off her forehead, and the setting sun full on her face. Would not this be a pretty Bewick?"

Her father, who had now finished what he was reading, and who was always cheerful and sociable, put away his book, and looked out of the window, joining with Lucy and her mother in their diversion. Presently he saw an old man and woman trudging together down a lane that led to a wood, and he began to sing a favourite song of Lucy's, in which she immediately joined:—

"There was an old man who lived in a wood,
As you may plainly see,
He said he could do more work in a day
Than his wife could do in three.

"With all my heart, the old woman said,
'If you will me allow,
You shall stay at home to-day,
And I'll go follow the plough.'"

Harry turned about, and looked much discomfited by the singing; and Lucy said—

"Join us, Harry, oh! join us, you know it."

But Harry replied only by stopping both his ears, and hanging again out of the carriage window farther than before. The singing in full glee was continuing, when Harry drew in his head, and rubbing his hands, exclaimed, as he threw himself back in his corner—

"I have it! I have found it out, papa!"

His father did not ask what he had found out, but went on singing.

"Father," said Harry, "will you explain to me now what is meant by a patent, or by taking out a patent for an invention?"

"I am singing, do not you hear!" said his father. "Go on, Lucy, go on singing with me."

When they had finished the song, Harry asked his question again about the patent for an invention, but his father did not listen to him.

"Papa," cried Harry, after eagerly waiting for the moment when, as he thought, he could fix his attention; "I want to tell you what I have been thinking of all this time."

"I do not want to hear it, Harry," said his father; "I cannot turn my mind to what you are thinking of; I will go on with my own thoughts."

So saying, his father put himself into Harry's late position, hanging over the side of the carriage.

"Well," said he, at last turning to Harry, who looked doleful, "you feel how unpleasant it is not to have people ready to sympathize with you; you feel how disagreeable it would be to you if we could not turn our thoughts to what you are thinking of when you wish for our attention."

Harry, looking ashamed, said, "That is true, papa, I believe I have been all day very disagreeable; but I did not mean it; I was thinking of something that I hoped you would be pleased with, and I did not like to leave off till I had quite invented it, or at least made it as good as I could."

"Oh! papa," said Lucy, "may I speak? You ought to be pleased with his going on persevering through all the noises we made, and every interruption. I am sure I could not so have fixed my attention."

"You and your brother, my dear Lucy," said her father, "have two opposite faults, and I wish you both to know them, that you may take care and use your power over your own minds to cure them. Your at-

tention, Lucy, passes too quickly from one thing to another. You are what is vulgarly called birdwitted. You should endeavour to prevent your mind from flying off from one subject to another: I encourage you to fix it as steadily and as long at a time as you can. You are of such an affectionate, sympathizing temper, that there is no danger that you should not be ready enough to turn your thoughts to the pursuits and amusements of others, whenever it is necessary or agreeable. You, Harry, have acquired the power and habit of fixing your attention steadily on your own pursuits, but you cannot easily turn your mind from your own thoughts to what is going on near you, or to what other people wish you to think of. Now consider that your sister and your mother, and I and everybody, like sympathy, as well as you do, probably; and if you acquired this unsociable habit of never joining in what we are doing, or being interested in what we are saying or hearing, you would become a very disagreeable companion."

"I hope I shall not," said Harry, with a look of serious alarm.

"You have perseverance and laudable ambition enough," continued his father; "but the danger for you is, that you should confine your attention too much to one small circle of objects, and not enlarge your mind by general observation and knowledge. You perceive that I speak to you not as to a foolish child, but as to a reasonable creature, who is desirous to improve himself. On this journey you will have opportunities of curing yourself of this fault. When you are going through a new country, look about you, observe every thing. When you are with people who are talking on subjects that are new to you, listen to what they say. Much knowledge and amusement can be gained by the ear as well as by the eye. 'Ears and no ears' might make a good tale as well as 'Eyes and no eyes.'"

"He did listen the other day, papa," said Lucy, "and heard what the gentleman told about the wreck and the gunpowder: Harry repeated it to me afterward."

"As he was so well rewarded by hearing what was entertaining, and by your remembering it so kindly," said her father, "I hope he will continue to attend to conversation."

"If people did not talk so much nonsense generally, in company, sir," said Harry, "I should listen oftener."

"Pick out the sense: if you try to do so, you will always find some golden grains of sense even in an ocean of nonsense. And suppose you should not, it will be of use to your own mind to interrupt, even by nonsense, the course of your thoughts. The mind becomes stupified when it has thought too long on any one point."

"True," said Harry, "so I found to-day, when I was thinking about my measuring-wheel. When I had thought and thought for a great while, I grew quite tired and stupid; I could not tell what was the matter with me; I could not invent what I wanted; and listening even to the moschetoes, which I hated at the time, did me good."

"Harry is so candid," said his mother, "that there is really some pleasure in finding fault with him."

He was not like those foolish boys, who, when they are told of any fault, think only how soon the person who is speaking will have done, that they may get rid of the immediate pain. Nor was he one of those who think only of what excuse they can make. Nor yet was he one of those (the most foolish) who grow sulky, and sit or stand like statues, feeling all the time as if the nightmare prevented them from stirring. It is true that Harry was acquainted with this disagreeable sensation, arising partly from shame, and partly from pride; but he struggled against it, and threw it off as soon as possible.

"Lucy, what were you doing before all this began?" asked Harry.

"We were singing the 'Old Man in the Wood,'" said Lucy; and then she added, in a whisper, "should you like to sing it again? if you would, I will begin it."

"I should," said he; "begin."

She began, Harry followed, and their father immediately joined them. They sung but badly, but they were all well pleased with each other, and Lucy said she was now *quite* happy.

"There must be some *nonsense* mixed with wisdom now and then, must not there, papa?" said she, "or else one is apt to grow terribly tired."

Our travellers next arrived at Frankland Hall, in Staffordshire, where they were to spend three days with their friends, Mr. and Mrs. Frankland.

The first day, at dinner, an old gentleman observed that the pie-dishes of Wedgwood's ware were good contrivances for keeping vegetables hot, and remarked, how very like real pie-crust one of them looked.

Mr. Frankland, who had been an intimate friend of the late Mr. Wedgwood, said that he was present the first day when one of these imitations of pie-crust appeared at dinner: the children of the family did not mistake it for a real pie, and Mr. Wedgwood had new ones made repeatedly, till at last one appeared so perfect, that, at a little distance, it could not be known from pie-crust. "When I took off the cover," said Mr. Frankland, "the child next me was agreeably surprised to hear it jingle on the dish."

"Besides this," said the old gentleman, "Mr. Wedgwood made a number of little every-day useful contrivances; that dish, in which there is a well for the gravy. In the olden times, unhappy carvers were obliged to poke under the heavy sirloin for gravy; or to raise and slope the dish, at the imminent hazard of overturning the sirloin, and splashing the spectators. Knife, fork, spoon, slipping all the while, one after another, into the dish! And, ten to one, no gravy to be had after all! Nothing but cakes of cold grease. But now, without poking, sloping, splashing, the happy carver, free from these miseries of life, has only to dip his spoon into a well of pure gravy. Thanks to the invention of one man, all men, women, and children may now have gravy without stooping the dish. So I give you, gentlemen and ladies, for a toast, 'The late Mr. Wedgwood, and the comforts of life.'"

After he had drunk his glass of wine, the old gentleman continued speaking:—

"I remember that Mr. Coxe, the traveller, was pleased by meeting with a beautiful service of Wedgwood ware in Russia. I dare say he might find one now in Siberia. Last year, when I was in Holland, I learned that even the town of Delft, which for many years used to furnish all Europe with crockery, is now supplied from England with our Staffordshire ware."

The conversation next turned on China, and Chinese artists.

"They are very exact," said Mr. Frankland, "in imitating whatever is bespoken from them, but sometimes they carry this to a degree of provoking stupidity."

Of this he gave an instance. A lady wanted to match some of the plates of a remarkably handsome service of china, which had been given to her husband by the East India Company. She sent a pattern to China, and bespoke some dozens to be made exactly the same. In due time they arrived, were unpacked, but, to her surprise and mortification, the lady found that every one of the new plates had the appearance of a crack across it; and, on examining the plate which had been sent as a pattern, it was found that there was a crack in it, which had been exactly imitated.

Even Harry, though he loved exactness, thought this was too much.

Lucy observed the beauty of the china. On her plate there lay, or there seemed to lie, a convolvulus: it looked so natural that she thought she could take it up. On her mother's was a Celsia, a geranium on another, and on Harry's a honeysuckle, of which she could almost fancy that she smelt the perfume. Even as she ate her ripe cherries, she paused to examine these flowers. She thought it the most beautiful china she had ever seen. When she went into the drawing-room she saw on the chimney-piece flower-pots of the most delicate blue, with white figures on them, embossed like ivory, and exquisitely carved. The drapery on the figures was so light, that it seemed as if blown by the wind, and so transparent, that she could see the blue ground through it.

Mrs. Frankland came to Lucy as she was looking at these flower-pots, and told her that they were Wedgwood's ware, as well as the plates which she had admired at the dessert.

"Wedgwood's ware!" repeated Lucy. "I thought that Wedgwood's ware was always black or cream-coloured, such as the common yellowish plates."

Mrs. Frankland told her there was a great variety of Wedgwood's wares. She took her into a cabinet at the end of the drawing-room, where she showed her several vases, made in imitation of antiques, which had been dug up from the ruins of Etruria, in Italy, and thence called Etruscan. Some had red grounds, with black figures; others red figures, on black grounds; others, which were jasper, were very valuable. After Lucy had examined and admired all these, Mrs. Frankland said she would show her another, which was more

valuable than all the rest. The original, from which it was exquisitely imitated, cost the present possessor four thousand guineas. As she spoke she opened the case which contained the vase, and carefully raised it from its crimson-cushioned bed.

"I know it, I have seen it before, mamma," exclaimed Lucy.

"Seen it before, Lucy!" said her mother. "Where?"

"In a book, when I was reading to you, mamma."

"You mean, that you have seen an engraving of it," said her mother.

"Yes, mamma, you remember the three views in the Botanic Garden, of a vase just like this, with a dark ground and white figures. I cannot recollect the name of it, but I know it was dug up out of ruins."

Her mother told her it was called the Barberini, or Portland vase. *Barberini*, from the name of the Italian family to whom it had belonged; and *Portland*, from the Dutchess of Portland, by whom it had been purchased, and brought to England.

Lucy, whose memory was now awakened, recollected Dr. Darwin's beautiful lines addressed to Mr. Wedgwood; "Oh friend of art!" but she refrained from repeating them, for which Harry gave her credit due.

Mr. Frankland, who now came into the room, told her that the ancient Etruscan, or Greek vases, were produced by a different process from that which Mr. Wedgwood used in making his. They appear to have been made by covering the parts representing the figures and ornaments, after their outlines had been traced, and then dipping the red ware in a black paint. The lines of the drapery, &c., were afterward traced in the same colour. In those ancient vases, the colour, which was red, was in the *body* of the ware itself. In Mr. Wedgwood's imitations, both the red and black are painted *on* the porcelain, or rather on the *biscuit*; the name which is given to the ware after its first baking in the furnace. He was the first person who made what are called dry colours, or enamel, without lustre, without shining.

Harry thought that the smoothness and polish of these vases were more beautiful than any glazing.

"And much safer, and more durable," said Mr. Frankland. "These colours cannot be injured by damp, or fire, or air, or acid, and will last as long as the sub-

stance itself. You may have observed that the glazing on common earthenware runs into little cracks."

"Yes," said Lucy, "I have often observed them covering a plate like network. They look very ugly."

"But what is much worse," continued he, "in most kinds of glazing, lead is employed; which, when dissolved in certain acids, is poisonous."

Lucy observed that *glazing* looked something like *glass*, and from the sound of the words too, she believed *glazing* came from *glass*. It might at first have been called glassing."

"Yes," said Mr. Frankland, "and there is, as you observe, a resemblance between the outside of some porcelain and glass. But the difference between glass and porcelain is, that porcelain is but *semivitrified*, that means half turned to glass. The managing the heat so as to stop the vitrification, or turning to glass, at the right time, is one of the most important points in making porcelain."

Lucy returned to admire the beauty of the Wedgwood's ware, repeating, that she thought it much prettier than Chinese china.

"Besides the beauty of form, and colour, and texture," continued Mr. Frankland, "the utility is great. It is not only perfectly safe for all culinary purposes, but most durable for some chymical experiments, in which the vessels must be exposed to great heat."

Mr. Frankland showed them a crucible and a retort, made of Wedgwood's ware, and Mrs. Frankland showed a white pestle and mortar which looked like marble, but which were of Wedgwood's ware, and used for pounding medicines.

Harry asked whether the potteries where all these were made was near Frankland Hall.

"Yes, within a few miles of us," said Mr. Frankland, "at a village to which Mr. Wedgwood gave the name of Etruria, and where he established a manufactory, whose productions are probably more known, and more useful to a greater number of people, than ever were those of the ancient Etruria."

Mr. Frankland said that he would the next day take Harry and Lucy to see these works. In the meantime, as Harry seemed anxious to know more, he told him all that he thought could interest him concerning the history of the Staffordshire potteries. The clay of this

part of England being fit for making some kinds of earthenware, there have been potteries, or remains of potteries, in Staffordshire, ever since the time when the Romans were in Britain; but they had continued in a rude state for ages, as no person of industry or knowledge had attempted their improvement till about a hundred and twenty years ago, when two brothers of the name of Elers came from Holland, settled here, and manufactured a red unglazed porcelain. Afterward they made a sort of brown glazed stoneware, coarse and heavy, yet the glazing of these, such as it was, could not be performed without great inconvenience. They used muriate of soda, which they threw into the oven at a certain time of the baking of the vessels. The fumes from this were so odious, that the neighbourhood were alarmed, and forced the strangers to abandon their potteries, and quit the country. Soon afterward, a workman who had found out the secret of their mode of glazing, for even that was a secret, pursued the same method in a pottery of his own; and this was suffered to go on in spite of the nauseous fumes, because the inhabitants found the jars they made so useful for holding their butter. They were employed chiefly for this purpose, and the manufactory was called the Butter Pottery. On glazing days, however, the nuisance was terrible; the offensive fumes spread to the distance of six or seven miles. Thick clouds from these furnaces rose over the hills, and filled the valleys with their dense vapours.

The first great improvement in our potteries was made in the substance of the ware itself, by introducing ground flints into the composition, and then was made what is still called white stoneware. It is used for many purposes. You may have seen it, for instance, for Seltzer water-bottles.

"I know what you mean," said Lucy.

"This was the safest and best ware we had," continued Mr. Frankland, "before Mr. Wedgwood's time. It is said, that the first idea of using powdered flints was suggested to a poor Staffordshire potter by accident."

"By accident! I am glad of it," said Lucy. "I like to hear of discoveries made by accident, especially by poor people."

"There was a Staffordshire potter, whose name is forgotten, or whose name I forget; he stopped on a jour-

ney to London, at Dunstable, in Bedfordshire, where the soil is flinty and chalky. He consulted the hostler of the inn where he stopped, about some disorder in his horse's eye. The hostler advised that powdered flint should be put into the eye; and for this purpose he threw a flint into the fire to *calcine*, that is, to burn it, that it might be more easily pulverized. The potter, who was standing by, observed the great whiteness of the calcined flint, and being an ingenious, as well as an observing man, immediately thought of applying this circumstance to the improvement of his pottery. He first tried the experiment of mixing finely-powdered flints with tobacco-pipe clay; he succeeded to his hopes, and made white stoneware, which put all the brown and coloured stoneware out of fashion. Ugly as you think it, Lucy, it was much approved till Wedgwood came, and gave us something better—that cream-coloured ware, which was called queen's ware, because it was first patronised by Queen Charlotte. It was then, and not many years ago, prized in palaces; now it is used in every cottage, and known in every place where plates or dishes are to be found. After this queen's ware, he invented all the varieties which you have seen, and many more."

Mrs. Frankland rang the bell, and ordered the servant to bring a plate of cream-coloured Wedgwood ware, another of the white stoneware, a crock of the dark glazed kind, and a common red garden-pot; these she placed in the order in which they had been made, beside Wedgwood's beautiful vases, to show Harry and Lucy the difference and contrast.

"And all these improvements, or at least the greatest part of them, were made by one man," thought Harry. "Then more was done by him during his lifetime than had been done in hundreds of years before."

Lucy asked if any lucky accidents had happened to Mr. Wedgwood, which put improvements into his head, or gave him the first idea of any of his inventions? She said she should like very much to know the story of these, if Mr. Frankland would tell it to her.

Mr. Frankland said he did not know of any such, and observed, that though one or two fortunate accidents might occur to the same person, it was not possible that such progressive improvements as Mr. Wedgwood had made could have been suggested by accident, or ac-

complished by any one who had not scientific knowledge.

"I should like very much," said Harry, "to know what he did first, and what he did next, and how he went on from one experiment to another."

"Of all this I cannot pretend to give you a history," said Mr. Frankland; "for I am not sure that I know it clearly myself. All I can tell you is, that he improved the potteries by the introduction of substances which had not before been employed in the composition of these wares. It had been found that some Cornwall granite is as good for making porcelain of a certain kind, as the clay which the Chinese use. Mr. Wedgwood introduced Dorsetshire and Cornwall clays."

"Perhaps you could tell me, sir," said Lucy, "how the delicate blue of the ground of this flower-pot is made."

"That is given by a substance called cobalt," said Mr. Frankland. "But, as you have never seen it, the word cobalt teaches you little."

"I wish I knew," said Lucy, "how the beautiful colours of the flowers on the dessert-plates, and how the purple and rose colours on this cup, are produced."

"The purple and rose colours are given by the precipitate of gold dissolved in nitro-muriatic acid; the oxydes of iron also produce many of the colours which you admired. But, as you are not acquainted with any of the oxydes of iron, or with nitric or muriatic acid, or with the precipitate of gold, you know nothing more from my answer than a number of names, which probably you will not be able to remember an hour, and which, unless you learn their properties, could be of no use to you, even if you could keep them in your head all your life."

"But without telling us all those hard names, sir," said Lucy, "could not you give us some general idea of how he did it all?"

Mr. Frankland smiled, and answered, that he did not exactly know what she meant by a general idea of it all. He could tell her only that Mr. Wedgwood, in the first place, learned the properties of different clays and minerals, and what effect would be produced on these by fire. In short, he applied to the study of chymistry and mineralogy, to learn all the experiments which had been made by others, and then he tried new ones for himself; but if he had not read and acquired this knowl-

edge first, he might have wasted his time and ingenuity in doing what others had done before him. Besides genius to invent new and elegant things, he had the good sense to observe what is wanted every day by the greatest number of people; so that he not only produced what pleased persons of taste, but what was useful to all classes; and he continually considered how he could improve, not only what others made, but what he had himself produced. It was by this attention to little as well as to great objects, and by steadily adhering to one course of pursuits, that he succeeded in accomplishing all that he began: no small praise for a man who undertook so much. "The consequences of his success we all know," continued Mr. Frankland, turning to Harry's father, "and we all rejoice in them. Wedgwood made a large fortune for himself and his children, with a character, a reputation, above all fortune. He increased amazingly the industry, wealth, and comforts of the poor in his neighbourhood; multiplied the conveniences, elegances, and luxuries of life for the rich; raised, at home and abroad, the fame of the arts and manufactures of his own country; extended her commerce, and spread his own name, with his productions, to the most remote regions of the civilized world."

A pause ensued after these words; all looked with admiration at his works, and those who had known him intimately sighed for the loss of an excellent man and a kind friend.

The next day, Mr. Frankland took Harry and Lucy to see the works at Etruria. We shall not follow them through all the processes, but shall only mention what Harry and Lucy recollected and told their mother on their return.

"The first thing I remember," said Harry, "is the improvement in the way of grinding the flints."

"But you must know, mother, in the first place," said Lucy, "that formerly this was very unwholesome work, such a quantity of the dust of the powdered flint flew off; and, as the workmen breathed, it went in at their mouths, or up their noses, and it brought on complaints in their lungs and stomachs, and inflamed their eyes besides."

"All this was remedied," continued Harry, "by grinding the flints in water, which prevented the dust from flying off. The name of the man who made this im-

provement, and who made the first mill on this principle, was Brindley, and the mill is very ingenious."

"But you had better not stop to describe that," said Lucy, "because perhaps mamma does not care as much about it as you do. Now let me go on, Harry, and tell a little. Well, mamma, the flints ground in the great *coldron*—"

"Mill," said Harry.

"Mixed with water," continued Lucy, "looked at first like chalk and water, thickish; then by mixing with clay, and by stirring, and beating, and straining through sieves, this became first a sort of pulp, and then about as thick as paste or dough, and then it was ready for the man to carry to the potter's wheel. You know the potter's wheel, mamma? I remember first seeing the print of it in our book of trades. But there is an improvement in this. The very common one, which I once saw long ago, was only a circular board turning on a perpendicular stick."

"Axis," said Harry.

"A boy whirled it round for the man, you know, mamma, while he went on moulding the clay upon it into a bowl, and he called to the boy to make it go slower or faster. But in this potter's wheel no boy to whirl the board is wanting, for it is turned by a shaft."

"And that shaft is turned by a steam-engine," said Harry. "The steam-engine, mother, at work again; observe, mother."

"Yes," said Lucy, "papa called it the great servant of all work."

"But there was an improvement in this potter's wheel, which you have not told yet, Lucy," said Harry.

"No, but I am coming to it; let me tell it," said Lucy.

"If you understand it," whispered Harry, in a very kind tone, as he was only afraid for her, not anxious to show what he knew.

"I understand one thing about it, and that is all I want to tell, my dear," said Lucy. "But I will begin another way. You know, mamma, that it is necessary to make the potter's wheel go slower or quicker, whenever it is desired by the man who is moulding the clay. Formerly this was done by a boy, who turned it faster or slower as he was bid; but the steam-engine, which is now used for keeping this wheel in motion, goes on continually at its own regular rate, and would never mind his calling out 'faster!' 'slower!' 'slower!' 'fast-

er?' Therefore he must have some way of slackening or quickening the wheel without interfering with the steam-engine. This is done for him by the new contrivance, which I will now describe to you, if I can.

"Imagine, mamma, two sugarloaf-shaped rollers; two cones of wood, standing one with the point down, the other with the point up, and turning on pins run through them, like your silkwinders: these cones are placed at some distance from each other, opposite to the potter's wheel. Suppose that they are set in motion and kept in motion by the steam-engine, and that motion communicated from one of them to the potter's wheel. Very well. Then next, mamma, imagine a band passed round these two cones, in such a manner that it should always be at the thicker part of one cone, while it is at the thinner part of the other. Then, when the man wants his great wheel to go faster, he shoves up the band to the thinnest part of the cone which is connected with the wheel, and if he wants it to go slower he pushes the band down to the thicker part; something like the way, mamma, in which, as you may remember, we have seen old Margery with her spinning-wheel shift the band from the larger to the smaller rim of her wheel. Harry took notice of the cones as soon as he saw them, and asked what was their use. Papa bid him find out, and he did. Was not that well, mamma?"

"I am glad you remember this, my dear Lucy," said her mother.

"Thank you," said Harry's eyes.

Lucy went on with raised spirits: "Mamma, I wish you had seen the man moulding the clay, and all the metamorphoses of the potter's wheel. First, in one minute, the lump of clay turned into a bowl; then, the instant after, he squeezed this soft bowl up in his hand, dashed it on the wheel, and again he turned, and moulded, and in an instant it was a plate! In another instant the plate was gone, and in its stead a cup stood before us!"

"A cup without a handle," said Harry.

"The handle, if wanted, must be made separately, and stuck on afterward. Only certain shaped things, round or flat, are made on the potter's wheel. Those which have *ins* and *outs* in their shapes are made in moulds, into which the moist clay is squeezed; sometimes two parts of a thing, the spout of a teapot, for instance, are made in separate moulds, and the halves joined together afterward. But I dare say, mother, you know all this."

"I know most of this myself before," continued Lucy, "from the prints and descriptions in our dear book of trades, and from some others of our little and large books. But I liked to see the real work going on, and the real things. There was always some difference between the description and the reality, or something that I fancied larger or smaller than it is, or some little particular circumstance which I did not comprehend till I saw it. Mamma, I did not tell you that we saw the furnaces and kilns, for baking—*firing* the porcelain, as they call it. These were much larger than I expected. When the porcelain has been once baked, it is called *biscuit*, in which state it is ready for painting. Mamma, I have not told you how much I was entertained in the painting-room, by seeing how dull the colours look when they are first laid on, and how bright and brilliant they are after they have been fired—what was to be gold was quite dark beforehand."

"Pray, Lucy," said Harry, "did you observe a man who was standing beside one of the furnaces, whose business seemed to be to regulate the heat? He had some little bits of clay, which looked like little stoppers, and he put these into the fire and measured them, did you see how?"

"No; I saw the man," said Lucy, "but I did not know what he was doing. Well, mamma, there is one other thing I remember, and that is all. You know the common kind of blue and white cups and saucers, and plates, with windmills, and houses, and strange Chinese-looking figures, and all manner of things upon them?"

"I do know, luckily, what you mean," said her mother, laughing, "otherwise I am not sure that I should know it from your description."

"Mamma, these were formerly painted, one at a time, by hand, but now there is a much quicker way; Mr. Frankland showed it to me. First, the patterns, whatever you wish, houses or churches, or geese or turkeys, or shepherdesses, or elephants, or windmills, are printed on paper."

"*Engraved* on copper first," said Harry, "and the blue colour put upon the copperplate, instead of printer's ink."

"And the blue colour—oh! let me tell that, Harry!" cried Lucy; "the blue colour is made of cobalt."

"*Oxyde* of cobalt, I believe," said Harry, "which dif-

fers from cobalt, Mr. Frankland told us, if you recollect, Lucy, as much as rust differs from iron."

"Well, oxyde of cobalt it should be, I recollect," said Lucy; "and this is mixed with some earth and—"

"And linseed oil," said Harry; "like what is used in printer's ink."

"And when it is altogether about as thick and soft as paste, it is put on the copperplate. You know, mamma, you showed me common engraving once: and just like any common engraving this is done. As many copies of patterns are taken off on paper as you want."

"You forgot that the paper was smeared first with soft soap," said Harry.

"Then, when you want to use these patterns," said Lucy, "the superfluous paper is cut off, and the printed part is moistened and laid on the cup, or whatever you wish to put it on."

"The cup must be in the state of biscuit, remember," said Harry.

"Biscuit, to be sure," said Lucy; "the biscuit instantly sucks in, absorbs the colouring stuff, from the moistened pattern, then the paper is washed off, and you see the coloured pattern printed on the cup directly. Is not that nice and quick, mamma? Then the cup must be let to dry, and afterward it is dipped in some sort of glazing stuff, and the cobalt, I mean the oxyde of cobalt, comes out a beautiful blue. And there is the cup finished, painted in this easy, expeditious way: a hundred thousand, I dare say, could be painted in this manner, while a person could paint one single cup in the old way."

"The name of the ingenious person, as Mr. Frankland said, who discovered this method of transferring engraving from paper to earthenware, has not been preserved, and I am sorry for it," added Harry.

"Mr. Frankland told us, that since this invention, this blue and white ware has been made in such quantities, and so cheap, that now almost everybody can afford to buy it, and it is in every cottage; and the poor people can have now what only the rich and grand had formerly. Are not you very glad of that, mamma?"

"Yes, I am, my dear," said her mother; "and I am glad," added she, smiling, "that you give yourself time to take breath at last, and that you allow me time to thank you for all you have told me. You seem to have

been very much entertained at the potteries, and you have entertained me by your account of them."

"Mamma," said Lucy, "do you think we have remembered enough? I know I cannot recollect half what I saw and heard, but I remember almost all that I understood clearly."

"That is quite enough, my dear," said her mother; "I never wish you to remember more than you understand. Of what use could it be?"

"Good morning to you, mamma," said Lucy. "I forgot to tell you yesterday, when we were talking about the potteries, that we saw the house in which Mr. Wedgwood formerly lived; and a very nice house it is."

"Good morning to you, father," said Harry. "Do you recollect yesterday seeing a man standing by one of the furnaces measuring some little stoppers of baked clay, which he slid in between two pieces of brass, like the two parts of a hinged ruler. These pieces of brass were fixed, but not parallel to each other; they were closer together at one end than at the other. The man took the bits of clay, or stoppers, out of a heated furnace, and he tried each stopper between these rules, and looked at divisions, which were marked on the brass plates. What was he doing, papa?"

"He was using a sort of thermometer, Harry," said his father.

"A thermometer of clay, papa!" said Lucy.

"Yes, for measuring higher degrees of heat than can be shown by that thermometer which you have seen; if that were exposed to heat beyond the highest degree marked on its scale, the quicksilver would expand so as to burst the glass, and the glass would melt if put into one of those furnaces which you saw yesterday; but these clay thermometers can bear and can measure the heat of the fire; for which reason it is called a *pyrometer*, that is, measurer of fire-heat."

"I am glad I know the name, and what it means," said Lucy.

"Father," said Harry, "will you be so good as to explain the pyrometer to me?"

"Harry, will you be so good as to use your own understanding!" said his father. "From what you have seen, and from what I have just told you, you know

"Papa, I remember seeing," said Lucy, "in Scientific Dialogues, the description of a pyrometer, but I do not think that it was made of clay."

"No, that pyrometer is different," said her father; "that measures by the expansion of metal bars with different degrees of heat, which is shown by the motion given to an index."

"Like the hygrometer," said Lucy.

"Yes; and there are several different kinds of pyrometers, of which you can read the description at your leisure," continued her father, "in any encyclopedia, if you have any curiosity about them."

"Yes," said Harry, "I should like to compare them, and see which is best, if I could."

"That would be a good exercise of your judgment, Harry," said his father; "but there are so many, they might tire and puzzle you."

"The clay of which Mr. Wedgwood's pyrometers are made," continued his father, "possesses some properties which fit it peculiarly for the purpose to which it has been judiciously applied. Those half-burnt bits of it which you saw, Harry, may be dropped at once into intense fire without cracking; and, when they have received its heat, may be plunged into cold water without the least injury. In about three minutes they acquire all the heat from any fire which they are capable of receiving, so as to contract as much as they ever will from that degree of heat. They may afterward be left in that heat as long as you please, for they will not change. Take them out, and they can, as you have seen, be cooled in a few seconds, and are then ready for measuring in the gauge, or scale."

"How very convenient!" said Harry. "But as each pyrometer-bit can be used but once, there ought to be a constant fresh supply."

"There are large beds of this clay in Cornwall," said his father; "and to ease your mind, Harry, on this subject, I can tell you, that Mr. Wedgwood offered to give the Royal Society a sufficient space of a bed of that clay, to supply the world with pyrometer-pieces for ages."

"I like that very much," cried Lucy. "I cannot bear that people who discover scientific things should be covetous of them, or afraid that others should have a share."

"How could you ever think of such a thing?" said Harry.

"I never should have thought of it," said Lucy, "only that I heard a gentleman once at aunt Pierrepoint's say—but I believe I had better not tell it, because it can do no good to anybody. But, Harry, I hope, and I am sure, that if ever you invent or discover any thing, you will be ready to let others share with you."

"That I will," said Harry; "oh! I wish it was come to *that*. Father, there is something else I want to say, but I do not know how to express it. It is, that I think that a person who invents any pyrometer, or hygrometer, or barometer, or new and exact instrument for measuring heat, or cold, or height, or quantity, does more service than a person who invents only a machine, which will do only for some particular purpose: because those measuring instruments will assist a great many other people in their experiments for years, perhaps for ages, to come. Do you understand what I mean, papa?"

"Yes, my dear, and I think what you say is very true. But do not twist the poor button of my coat any more, or you will pull it off; and let me go now, for there is the breakfast-bell."

"Who will be down stairs first?" cried Lucy, letting go her button, and running foremost. Harry might have overtaken her, perhaps, in a race across the hall, but that he stopped to hold open a swing-door for Mrs. Frankland. She had in her hand two small packets, one of which she gave to him, and the other to Lucy. On opening the paper in which these were wrapped, they found two cameoes of Wedgwood's ware. Lucy's, which was black on a white ground, represented a negro in chains, kneeling, with his hands raised in a supplicating manner, with this motto engraved,

"Am I not a man and a brother?"

Harry's cameo was all of one colour, brown. It represented three allegorical figures, Peace, Art, and Labour; and it was made of clay which had been brought from Botany Bay. Mr. Wedgwood made use of this clay, as Mrs. Frankland told Harry, on purpose to show the settlers and inhabitants of that country what could be made of their materials by industry and ingenuity; and thus he encouraged them to exert them-

selves. Of these cameoes the late Mr. Wedgwood distributed many hundreds. And no doubt considerable effect was produced by

> ——"the poor fettered slave, on bended knee,
> From Britain's sons imploring to be free."

"Lucy, you have not seen our garden yet," said Mrs. Frankland. "We had not time yesterday; but, if you are fond of a garden, come with us now, your mother and I are going there."

"Oh! thank you, ma'am," said Lucy; "but I must call Harry, and we will follow you directly."

They followed, and a gay garden it was, full of a variety of bright-coloured flowers, rich beds of carnations, and roses in full blow.

"Roses, moss roses in full blow in September!" cried Lucy. The day before she had left home, she had searched their garden for a rose for her mother, but could find only one poor solitary bud, which had a yellow nightcap on. She asked Mrs. Frankland to tell her how she contrived to make her roses blow so late in autumn.

"By pulling off some of the buds in spring," said Mrs. Frankland, "as soon as they begin to form, and by transplanting some of the rose-trees early in the spring, so as to prevent them from flowering at that time, then they blow in autumn."

Lucy said she would try this next spring on her own two rose-trees.

"Not on both, will you?" said Harry. "Let us pull the buds off one, and leave them on the other, then it will be a fair experiment."

"And besides, you may then have a chance," said Mrs. Frankland, "of the first rose of spring, as well as the last rose of summer."

Lucy took notice of some large clusters of bright blue flowers—agapanthas, and varieties of dahlias; she thought them beautiful, but she supposed that these could not be had without a great deal of trouble and money, and a hothouse, or a gardener at least. But Mrs. Frankland said these did not require a hothouse, or even a gardener's skill. "Indeed," said she, "all the flowers in this garden, excepting perhaps certain

carnations, which my gardener prizes highly, though I do not, may be had by anybody with a little care and exertion of their own."

"By anybody!" repeated Lucy. "But, ma'am, do you mean bodies like us? like Harry and me! with only our own hands?"

"Yes, bodies like you," said Mrs. Frankland, "with your own hands, provided you use your heads as well as your hands."

"In what way must we use our heads?" said Lucy; "will it be very difficult?"

"No; consult your gardener's dictionary, and follow its directions. Only remember to do so at the right time of year," said Mrs. Frankland. She told Lucy that she could give her the root of an agapantha, and of some dahlias, and that she and Harry were welcome to seeds, roots, cuttings, or slippings, of any thing they liked in this garden. "Write down what you wish, and I will have them ready by the time your mother brings you here again, as I hope she will on your return homewards."

Joy sparkled in their eyes, and they thanked Mrs. Frankland, with warm gratitude; but, an instant afterward, they looked unusually grave; for the embarrassment of riches came upon them. They were left to make out their list; and how to choose was the difficulty, where all were beautiful, and when their little garden could not hold all. Harry went to work prudently. He measured out a space of ground that was the size of their own garden. Lucy could hardly believe that it was so small as what he now showed her; but he had often stepped the boundaries, and was sure of the size of their territories. Rule and measure soon settled the affair, and brought their wishes into proper compass. They calculated what their garden would hold, and made out their list accordingly. Their chief wish was to have a great bed of pinks and carnations.

But the moment they went near these, an old gardener, who was at work in the garden, and who had long been eying them, approached. He began to praise his carnations, which he said were the finest in the county, and he pointed out his favourites. There was the Prince Regent and the Duke of Wellington in full glory, these everybody knew; but beyond these he had two superlative new favourites. One he called *The Pride of*

Holland, or the Great Van Tromp. The other, *The Busy of the World, or the Great Panjandrum.* Harry and Lucy did not much admire either of these. Van Tromp they thought was of a dull colour, and the great panjandrum had burst, and was falling to pieces in spite of his card support. Harry preferred some others.

"That which you are now at, master," said the gardener, "is Davy's Dutchess of Devonshire: that little dutchess was thought a great deal of some years ago, but she is quite out of fashion now."

Harry did not care for that, he liked her.

"What does he say?" asked the deaf gardener, turning to Lucy, and leaning down that he might hear the answer.

"I say," cried Harry, speaking loud in his ear, "that I like my little dutchess better than your great panjandrum."

"Indeed!" said the gardener, smiling in scorn. "Why, master, what you have taken such a fancy to is not a carnation even, it is only a pink."

"I do not care," said Harry, "what you call it. I like it, whether it be called carnation or pink."

The gardener looked at him with contempt.

"Pray what is the difference between them?" said Lucy: "my mother has told me, but I forget it."

The gardener told her that one chief difference is in the roundness of the petals of carnations, and the jagged or pinked edges of the petals of pinks.

Lucy liked these edges, and she really thought some of the pinks prettier than the carnations. She told Harry so, in a low voice. "But I am afraid," said she, "that the gardener would despise me if he heard me say so."

"What signifies whether he despises you or not?" said Harry. "There is nothing wrong in liking a pink better than a carnation."

The gardener, who did not hear what was said, fancied that they were debating whether they should ask for one of his grand panjandrums, and he began to say that he was sorry that he could not offer this, he could not give this to anybody.

Harry assured him that he need not make any apology, because they did not wish for them. Piqued by Harry's indifference, the gardener named several lords and ladies who had admired his panjandrum above all things, and who had tried in vain to obtain it. It was

a very great rarity, he said. Only two other people in England had a real panjandrum.

Harry liked flowers for being pretty, and did not care whether they were rare or not.

The gardener did not believe him. Soon afterward he offered Harry some pinks of a kind which he liked particularly.

"But, master, I can let you have them only upon condition that you promise not to give any cuttings or layers of them to any one."

Harry drew back with disdain, and said he would make no such promise.

The gardener said that unless he would, he should not have the pinks.

"Then," said Harry, "I will do without them."

He turned off abruptly, and walked away; but Lucy stood still, and said,

"I believe we may have them. Mrs. Frankland told us we might have any thing in this garden that we choose; and here she is coming back from the orchard."

"Oh! that alters the case," said the gardener, with a look of some mortification. "Then, master, you must choose what you will, to be sure."

Harry turned back, and walked composedly along the sides of the carnation-beds, writing down the names of those he chose on a bit of paper. The gardener breathed freely when Harry passed by the panjandrum, and turned his back upon the envy of the world.

Lucy whispered to her brother, "Did you see how much he was afraid that you should have chosen any of those that are really valuable; and why did not you?"

"Because I did not like them, and I despise his mean reasons for liking them," said Harry, putting the paper and pencil into her hands. "Now go, Lucy, and choose."

Lucy, admiring her brother's independence, followed his example, and chose what she liked, without being influenced by the foolish wish of possessing what other people cannot procure. She did not choose either the pride of Holland, or the envy of the world.

Harry was quite right to adhere to his own taste: here was no trial of complaisance or generosity.

Mrs. Frankland and their mother now returned from

the orchard, and Harry and Lucy gave Mrs. Frankland their list. She looked it over, said she thought they had chosen well, and had been moderate in their requests. She called to her gardener, gave him the paper, and desired him to have the plants in readiness at the time she mentioned.

"Very well, ma'am," he answered, coolly looking over the list, which he saw was only of common flowers; but when she added that he must also give some Dutch hyacinths and tulip-roots, the gardener's whole countenance changed: he exclaimed, "My Dutch tulips and hyacinths!" and throwing down a hoe that he had in his hand, he walked off, muttering to himself, "that it was well his mistress's head was not loose, or she would give it away."

Mrs. Frankland laughed good-humouredly at his anger. She bore with him, she said, because he was an old and faithful servant, who had been long in the family before she was married. "Though you might not think it," said she, "he is generous to his relations, of all that belongs to himself, and covetous only of what belongs to the garden, of which he considers himself as guardian against his mistress's extravagance. But I cannot bear this sort of petty avarice and rivalship about flowers, in persons whose education ought to have raised them above such illiberality. I have heard of a lady who, when she was asked by a friend for the roots of some particularly fine flower, ashamed to refuse, yet unwilling to give, boiled the roots before she sent them, to prevent the possibility of their growing."

Harry expressed the greatest indignation against this meanness.

They now entered the conservatories, and observed the flowers of a plant which hung over the entrance of the peach-house. They looked as if they were cut out of thick velvet, and were covered with honey. Their smell, which had been pleasant at first, soon became disagreeable and overpowering. Mrs. Frankland told Lucy that this plant is called *Hoya carnosa*; *Hoya* from the name of Mr. Hoy, the gardener who introduced it into England; and *carnosa* from the fleshy appearance of the flower. She had planted it at the door of the peach-house, because it is there a useful guard. Wasps are so fond of its honey, that they will, for this, leave untouched peaches and grapes. After they had seen the

peach-house, they walked through the conservatory, where Mrs. Frankland pointed out a tree called the Papaw tree, *carica papaya*, which had been brought to her lately from the West Indies. The gentleman who gave it to her told her that it would grow twenty feet in three years; that its juice has the singular property of making meat tender; if the juice be rubbed on beef it makes it as tender as veal; and if an old fowl be hung on the trunk of this tree, it becomes, in a few hours, as tender as a young chicken. This, it is affirmed, is a fact which has been long known to those who have resided in the West Indies. But Mrs. Frankland said, as she had not yet tried the experiment, she could not assert it to be true.

At this moment, Harry put his hand to the mouth of one of the flues or pipes in the conservatory, and perceived that warm air came through it; but Mrs. Frankland told him that this air was not well heated, and therefore did not heat the building as it ought. She said that a man was just going to alter, and she hoped to improve them. Harry heard his father talking to this man at the other end of the conservatory, and he went to see what was doing.

His father turned to him, and asked whether, if he were to place the pipe, he would put it at the top or the bottom of the building?

Harry answered, "At the bottom; because I know that heated air is lighter than air that is not heated, and therefore, if it is let in at the bottom of the building, it will mix with the colder air, and gradually warm the whole house as it rises to the top."

As Lucy walked on with Harry, she asked him how he knew that hot air is lighter than cold.

"As you might know," said Harry, "if you recollect a diversion we were fond of when we were children, and which I should like this minute." He puffed out his cheeks, and blew through his hand, as he turned his face up towards the sky.

"Blowing bubbles you mean!" said Lucy; "but what then?"

"What do you think makes the bubble go up?" said Harry.

"It goes up because it is lighter than the air."

"And how comes that? What is it filled with?"

"It is filled with air from the mouth, blown through a tobacco-pipe."

"Well, whether it is blown through a tobacco-pipe or not," said Harry, "is the air from your mouth hotter or colder than the outer air, do you think, when the bubble rises?"

"Oh! hotter to be sure; now I know what you mean The bubbles go up because they are filled with heated air. Indeed, I might have known from this that heated air is lighter than cold air; but I did not recollect it at the right moment. I wonder how you came to remember it so well."

Harry said that, besides the bubbles, another thing fixed it in his mind. A thing which he had seen when she was away from home. A fire balloon, which went up because it was filled with heated air. He was one of the persons employed to hold the great bag of the balloon over a fire made of straw. "It was all flaccid at first," said he, "as my father called the bladder which you may remember he showed us."

"Yes," said Lucy; "and if your balloon were filled with heated air, it would expand. I know that."

"Yes, but you do not know how it pulled," said Harry. "I felt it beginning to pull against my hands as it filled out; and at last, when it was quite full, it pulled so hard that I could scarcely hold it. But I was desired to hold fast, and I did, though my knuckles were burning. The instant papa cried 'Let go,' we all loosed it, and up it went to a great height, quite into the clouds. Oh, the pleasure of seeing it go up! and the pain of my knuckles, which were all blistered, fixed the whole in my mind, so that you need not wonder at my remembering it."

While they were talking in this manner, their father was still speaking to the workmen about the stove of the hothouse. They joined him, and listened to what he was saying. The man was asking Mr. Frankland if he had seen the new method of heating houses used in a neighbouring town. He had, and admired it much. It had been first attempted at the house of the gentleman by whom it had been invented, which it warmed most comfortably. Then it was tried at the county Infirmary, where it also succeeded to the satisfaction of the medical men and the patients. It was the invention of a gentleman who has for many years exerted his

great knowledge of mechanics for purposes of domestic comfort; and who has, in the most liberal manner, devoted his wealth, his time, and his inventive genius, to public works, useful to his native town in particular, and to mankind in general.

At this moment they were interrupted. Some visiters had arrived, and they returned to the house. When Harry went into the room he saw ladies with no bonnets on their heads, and one with artificial flowers in her hair; though not much skilled in such matters, he thought this looked as if these people were not merely morning visiters, but would stay to dinner, for which, as Lucy knew by his face, he was very sorry.

The next time they were alone together, in their mother's dressing-room, in the evening, after the company were gone, Lucy asked her brother if he had not been unhappy all day since the time they were interrupted at the stove; but Harry said that, on the contrary, he had been very happy; and that he had heard several entertaining things.

"At first," said he, "when I saw that woman with the artificial flowers in her head, I thought it would be a *company* day, and that it was all over with us."

"That lady was very good-natured to me," said Lucy, "in telling me something about the artificial flower which she wore. Did you observe it?"

"Not I," said Harry. "Yes, I believe I did see it; it was like a lilach; and I was glad it had no smell, for I dislike the smell of lilach in a room. But what did she tell you about it?"

"That she brought it from Italy. She asked me to guess of what it was made. I looked close, and I touched it, for she told me that I might. It was not paper, nor silk, nor gauze, nor cambric; I could not guess what it was, though I had an indistinct recollection of having seen something like it somewhere. It was made of the cocoons of silkworms. In Italy, you know, they have great quantities of these—in the silkworm's own country—and it is well to make use of them, instead of throwing them away."

"Yes," said Harry, "if there must be artificial flowers, and I suppose there must. That lady gave also an entertaining account of some travellers who were stopped by banditti between Rome and Naples."

"Yes," said Lucy, "and of the little girl who had her

mother's jewels given to her to take care of, and who concealed them in her doll's cradle, and who kept rocking the cradle and talking to her doll all the time the robbers were searching the carriage; so that they never suspected where the jewels were, and went away without finding them. I do not think I could have had courage or presence of mind to have done that. I wish I could."

"You do not know till you are tried whether you could or not," said Harry.

"But what was I going to say? I cannot recollect," said Lucy. "Oh! I was going to ask whether you heard what that lady told me about straw bonnets?"

"Not I," said Harry. "I heard her beginning to say something about the price and the fineness of hats. Women's business, thought I, to which I need not listen."

"Yet it was worth hearing," said Lucy; "though it was about bonnets, gentlemen listened as well as ladies."

"I am ready to listen now," said Harry.

"In the first place, Harry, do you know what Leghorn bonnets are?"

"Yes, I believe I do. A sort of straw hats. I know the things when I see them," said Harry.

"Very well; and you must know, too, that ladies think they are much better, because dearer, than others," said Lucy. "No, I mean much dearer, because better."

"Which is it? Are you sure," said Harry, laughing.

"Quite sure," said Lucy. "They are really better; they wear much longer, and bear wetting and crumpling. They are *infinitely* better."

"You know best. I am satisfied," said Harry. "That is settled; they are dearer because they are better. Go on."

"And they must be *much* dearer than the common straw bonnets which are made in England, you know, because they are brought from a great distance, from Italy."

"Ay, from Leghorn, I suppose, from their name," said Harry.

"Yes, at Leghorn first, I believe, and for a long, long time, hundreds of years, I dare say, ever since such hats have been worn, people never thought of its being

possible to make them anywhere but in Italy. The straw is plaited differently, and they thought that sort of straw could be got nowhere but there. In short, they never thought of looking or trying what they could do till lately. But now people have found out, first in America, I believe, then in England, and at last in Ireland—poor Ireland!—they have found a sort of grass, the straw of which will do, and they have learned how to plait it as well as they plait it in Italy. That lady showed us two bonnets, her own and her daughter's; her own she brought from Italy, and her daughter's was made in Ireland; and, as well as I could see, the Irish one was the finest of the two. And much better judges than I am, and people who looked through spectacles, and held magnifying-glasses to them, said the same. Several ladies in Ireland, as she told us, have taken a great deal of pains to teach poor girls this straw manufacture. One lady, who learned how to do it herself, from some directions in a common newspaper, set to work, and tried experiments."

"Sensible woman!" said Harry.

"And good," said Lucy, "for it was to do good. And, after a great many trials, she made a bonnet from the very beginning, with her own hands, from the first preparing the straw to the finishing; and she won the prize for this, the best that ever was made, I believe."

"Oh! now, Lucy, do not go too far. How do you know!" said Harry.

"I tell you just what was told me, my dear; that a person who saw it, and compared it with one which had been sent from Italy to some French princess, declared that the Irish hat was full as good as the finest of fine Leghorn hats, which cost fifty guineas. And this Irish hat was made of a very common grass, called crested dog's-tail,* which grows even on bad ground. Its flower-stalks are so remarkably harsh and tough that cattle will not touch them, though they will eat the dry stalks of many other sorts of grass. But these remain all winter in the fields useless; and they are called in Irish *trawnyeens*. When a thing is worth nothing, the Irish say it is not worth a *trawnyeen*. But now trawnyeens are made good for something, and for a great deal too."

"Would you know the grass if you were to see it?" said Harry.

* Cynosurus cristatus.

"Yes," said Lucy, "I know it very well, and I will show it to you the next time we are in any field where it is."

"Do," said Harry. "I like the woman who stuck to the bonnet till she had succeeded."

"She succeeded in doing a great deal more than making one fine bonnet. That would have been no great matter, only ingenious," said Lucy; "but I will tell you much more, and much better. This kind lady taught several poor Irish girls to make these hats; and two, not elder than fourteen, working in their own cottages (cabins they called them), made in one year twelve bonnets, and besides they did all the work that was wanted in the house as usual. Their twelve bonnets were sold for a guinea a piece. A great many such have been bespoken, and are to be sent over to London. The children of those poor Irish, who, as you know we heard, were almost starving last winter, have now one good way, by which they may earn guineas for their fathers and mothers."

"That is good indeed," said Harry. "I am sure that woman who made the first bonnet, and taught them all, must be glad."

"Yes, I am sure I should, if I were in her place," said Lucy. "And, Harry, mamma told me, that if I can learn to do this plaiting, I may teach it to our poor widow Wilson's daughters. To-day I saw a little bit of it, which the lady, who told us all this, brought in her workbag. She let me undo a bit of it, to see how it was done, and she gave us some straw, and we began to try."

"Now I know," said Harry, "why you were all plaiting straw so eagerly. I could not think what had seized you, when I saw you all so busy with straws when I came back from playing. But now, Lucy, to go to another thing, for we have said enough about this—did you observe the old gentleman who sat in the arm-chair by the fireside?"

"The same gentleman who, the first day at dinner, talked of Wedgwood's ware, and of vegetable pie-dishes?" said Lucy. "Yes, I saw him, indeed. He took a great quantity of snuff, and I could not bear—"

"What?"

"*It*. Oh, horrible, Harry!—his pocket-handkerchief—"

"I did not see it," said Harry.

"I am glad of it," said Lucy. "I do not like him."

"You do not like him! my dear. I assure you," said Harry, "he is a very sensible man; for I heard him talking to my father and Mr. Frankland about stoves, and flues, and fireplaces, and hot air."

"Very likely," said Lucy; "but I wish that he had not had those two great streaks of snuff along the wrinkles of his waistcoat."

"Never mind that," said Harry; "I want to tell you something entertaining he told me."

"Well, do then, I would rather hear it from you than from him," said Lucy. "I hope, Harry, you will never take snuff."

"No, no, my dear; no danger."

"But when you grow old, my dear, great danger. So many old people do, and young too. Now I will tell you the names of all the snuff-takers I know."

"No, no, no! my dear Lucy," said Harry, stopping his ears, "pray do not; but let me tell you about a little bird."

"A little bird—oh! that is another affair—I thought you were going only to tell me about stoves. What about a little bird?"

"It was about stoves too," said Harry; "you must hear that before you come to the bird. Do you recollect some one said that there was a disagreeable smell from a stove in the passage."

"Yes," said Lucy, "and the people began to debate whether it was a smell of smoke or of burnt air."

"Then it was that my old gentleman asked if they knew what is meant by *burnt air*, and he began and told of a doctor* somebody, who tried some experiments to determine whether heated iron gives out any thing unwholesome to air that passes over it, or whether it takes any thing away from it, in short, unfit for our breathing."

"So he took a bird, I suppose," said Lucy.

"Stay, stay; first he took a small cube of iron, and heated it to a great heat: I am sorry I forget the degree," said Harry.

"Never mind," said Lucy, "get on to the bird."

"And he put it into an exhausted receiver," said Harry.

* Dr. Desaguliers.

"The bird?" said Lucy.

"No, my dear, the cube of iron. I wish I had never told you about the bird."

"Well, well, I will not be bird-witted," said Lucy. "Papa, you know, told me I was bird-witted once: but, Harry, I beg your pardon. Now tell me; he took a small cube of iron, and he put it into an exhausted receiver."

"Yes," said Harry; "he placed the cube of iron so that whenever he let in air, it should all pass through a hole in the hot iron."

"You never told me of any hole in the hot iron," said Lucy.

"There I was wrong," said Harry; "I should have told you that he had made a hole through the iron cube; then he let the air into the receiver, and it passed through and over the heated iron; and when this receiver was filled with this air, he put a little bird into it; and it breathed the air without seeming to be in the least hurt, or showing that he felt any difference between it and fresh air."

"But the bird could not speak," said Lucy; "and we are not sure it liked it."

"Not sure, certainly," said Harry; "but now listen to the next experiment, and you will find what happened. The man made the same experiment with a cube of the same size of heated brass, and put the same bird in the same receiver, after it had been again exhausted, and filled with air which had passed through and over heated brass."

"Well," said Lucy, "and what happened?"

"The bird died," said Harry, "in a few minutes."

"Poor bird!" said Lucy. "The man was very cruel; I mean, the experiment was cruel."

"No," said Harry, "because he tried the experiment for a good purpose, to save the lives and health of human creatures."

"That was good," said Lucy; "but I think he might have tried the experiment as well without killing the bird. He should have taken it out when he saw it gasping for breath, as I am sure he did before it died. And he should have let it recover in the fresh air."

"Certainly," said Harry, "it was cruel, as you say, to kill the bird, because it was unnecessary. But, except that mistake, was not it a good experiment?"

She admitted that it was a good experiment; but she observed that the lungs of birds and of human creatures are different, and she thought it not quite a certain proof, that because a bird cannot live in such or such air, that therefore it must necessarily be unwholesome for human creatures. Her mother, to whom she appealed, thought this was true, and so did Harry.

"How much we have had to say and think of, from what passed to-day," said Lucy. "And how many curious facts and entertaining stories we heard in conversation, though we were so vexed at being interrupted when the visitors first came in!"

"Yes," said Harry, "I thought of that; and thought how right my father was in telling me that we may often learn as much from conversation as from books."

A BOATING party was proposed by Mr. Frankland, on the third and last day of their visit, and Harry and Lucy were invited to be of this party, at which they much rejoiced. They had never been in any boat. This had not a sail, it was to be rowed with oars. They walked down to the side of the river, which ran through the grounds, and they found the boat in a little creek, moored to a post in the bank. Lucy thought it a little dangerous to walk over the board that was laid from the land to the edge of the boat. One of the boatmen would have taken her by the arm, but as she saw Harry walk on fearlessly, she followed without assistance. They were desired to sit down as soon as they were in the boat, and something was said about *trimming* it. How or why a boat was to be trimmed, Lucy could not guess, and she was curious to see what would happen. Nothing happened, but that everybody sat still in their places, except one of the men who was to row, and who, sticking his oar against the ground, pushed off from the shore. Then crossing over Lucy's head with his oar, and bluntly saying, "By your leave, Miss," he succeeded in getting the boat out of the little creek in which it had been moored.

Now they were fairly out in the river, and all the boatmen began to row excepting one, who sat at the end of the boat, watching the way it was going, and guiding it by means of the rudder or *helm*, of which he held the great handle under his arm.

After they had rowed a little way, this man made one of his companions change places with another, who was much heavier; and then seeming satisfied, said, "She is well trimmed now." Lucy perceived that *she* meant the boat, and now understood that by trimmed he meant that the weight on each side of the boat was balanced.

All was new and amusing to Lucy; she listened to the sound of the oars, and watched the sparkling drops hanging from their edges, as the men lifted them from the water. They raised them out of the water, not edgewise, but with the flat part, or *blade*, horizontal, as you would raise a spoonful of any liquid. The use of this, as Harry perceived, was to diminish the resistance of the air against the oars, as they were moved forward, in order to replunge them in the water.

His father told him that this motion is called "feathering the oars.

"Now I understand," said Lucy, "that verse in the song of the jolly young waterman, which you used to sing, papa:—

"'Did you not hear of a jolly young waterman,
Who at Blackfriars used for to ply?
He feathered his oars with such skill and dexterity,
Winning each heart and delighting each eye.'"

As they rowed along they saw a pretty villa on the banks of the river. Lucy suddenly started up in the boat, and asked Harry if he should not like to live in that beautiful place with the gay veranda.

"Sit still, my dear," said her mother; "for if you overturn the boat you will never live anywhere."

Effectually quieted by this suggestion, Lucy sat down instantly, and quite still, silently enjoying the fineness of the day, and the pretty prospect of houses, gardens, parks, and woods, as they rowed on, and observing the reflection of the trees and buildings in the clear river. A bird, with white outspread wings, was skimming over the water, which Lucy wanted Harry to see; but he, close at his father's elbow, was intent on hearing what Mr. Frankland was saying of some foreigners who had lately been at his house, in the course of a tour they were making through England. He had taken them out boating; and in going down this part of the river they had been particularly struck, not merely with the picturesque beauty of the scenery, but with the appear-

ences of wealth, comfort, cheerfulness, and elegance in the residences of our English gentry. The great *territories* and *palaces*, as they called them, of our high nobility, did not surprise them so much as the vast number and variety of the lawns, and pleasure-grounds, and parks of our country gentlemen. One of these foreigners was French, the other Italian. In Italy there are fine palaces and fine gardens belonging to the nobility, but none of these comfortable habitations fit for persons in the middle ranks of life. The Frenchman said that these country houses were amazingly different from the comfortless *chateaux* in France. They had paid visits to several of our country gentlemen, and liked their mode of living so much, that even the Frenchman protested, that if he had not had the honour of being born a Parisian, he should *prefer* the lot of an English country gentleman *to* that of any other being in the universe. The Italian was further struck by the liberty enjoyed, and the equal justice done to all, as far as he could see, in England. He found that many of our most distinguished men have made their own fortunes, many risen by their own talents and exertions from the lower ranks of life. He found that, in this country, though birth has great advantages, education does more; and industry and genius have the road to fame, and wealth, and honours open to them; he would, therefore, as he declared, rather have been born in England, even in a lower rank, than in the highest class in any country where such equal laws and liberty, and such strong motives for exertion, are not to be found.

Harry understood all this, though it might seem a little above his years, and liked it the better, perhaps, on that account; besides, he enjoyed the praises of dear Old England.

There was in the boat a sailor, who was now called upon to sing for them, as he had a good voice, and knew many sailor's songs; and there was a boy who played on a flute. This boy was Scotch, and sang for them several pretty Scotch boat-songs.

The singing was interrupted by the man at the helm calling out rather unceremoniously to the boy with the flute, bidding him to have done with his *noise*, for they had something else to mind now. They were coming, as he said, fast upon the *weir*; and the men, who had been resting upon their oars, letting the boat float with

the current, while they listened to the music, now began to row *across* the stream, which was carrying them forward with increased velocity. Lucy imagined there was some danger, but what it was she did not know, for she had never seen a weir, nor had Harry; nor, if he had known, was it any time for talking. All was silent. The man who steered seemed intent on passing quickly through the current, and all hands joining in the pull, they reached and brought the boat safely into a little creek, where they moored her, by throwing a rope from her round the stump of a tree.

When they were all safely lodged on the bank, and while the boatmen were wiping their foreheads, Harry inquired if there had been any danger, and asked what was meant by the weir. Mr. Frankland said he would show it to him soon, but they could not see it from the place where they were standing. They walked on a little way on the shore, and presently heard a sound, as of waters falling, but still could not see from whence the sound came. It became louder and louder as they advanced, till, having passed the overhanging branches of a willow, which interrupted the view, they saw what caused the noise of falling waters. The stream was rushing down a step, formed by a long ridge or dam, which lay obliquely across the river. This ridge was the weir, and there might have been some danger if the boat had been carried too near it by the force of the current.

They were now to walk on to a place where they were to get into another boat, on a canal. As they passed along the bank, opposite to the weir, they had a full view of it, as the waters, arching over its rounding brim, formed a length of low, white, and greenish cascade, sparkling in the sun, and by its fall indented with changing lights and shades. While Lucy watched and admired these, Harry inquired what was the use of this ridge or weir, which he saw was not a natural step in the bed of the river, but which seemed to be built of mason-work, for some particular purpose.

Mr. Frankland directed his eyes to a mill on the bank, and told him that the use of this weir was to dam up the river, so as to secure a constant supply of water, and to give a fall sufficient to keep the wheel of this mill in motion. Harry wished exceedingly to have a nearer view of the water-wheel and of the mill. Windmills he

had seen and examined, but he had seen watermills only from the road. Mr. Frankland said it would not take them above half an hour to walk to the mill and back again, and was willing to grant Harry's request; Mrs. Frankland did not like to refuse him, yet she seemed doubtful; she looked at her watch, fearing that they should scarcely have time; she said that she was anxious to be home in good time for dinner, because she did not like to keep an old friend waiting. However, if the mill could be seen in half an hour, there would be time; she promised to wait for Harry; and his mother said that she would sit down on the stump of a tree, and make a sketch of the pretty situation of the mill, while he went to look at it. No sooner was permission granted, than Harry darted off, and was sure he should be back again in less than half an hour. But time passes quickly when we are amused, and when we are following our own particular tastes. First, the great water-wheel was to be seen, with all its vanes, and he stood observing how the water turned it. It was, as the millwright who came out to them said, an *overshot* wheel. Then it was to be explained to Harry what is meant by an *overshot wheel*, and the difference between this and an *undershot wheel*. This was a mill for grinding corn: he had seen flour-mills turned by wind, and as the construction of the mill-work was, as his father told him, nearly the same in this as in those which he had seen, there was no occasion to go over it. Indeed, he would have returned directly, but that he wanted to look at a crane, which was used for lifting up the sacks of corn from out of the boats to the granary, in the upper part of the mill, and for letting down the sacks of meal when ground. Harry thought he had been but a few minutes looking at this, and a few more minutes were spent in seeing a sack drawn up, and five minutes more in examining the motions of a certain *bolting* or sifting-machine, the operation of which, when explained by the overseer, particularly delighted him.

The overseer showed him that though the wheat, when it had passed through the stones, came out crushed or ground, yet that the finer parts were mixed with the coarse flour, as well as with the bran, or outer coat of the grain. In this state it was first spread out on a loft, in order to cool, and then it was poured down through a wooden funnel, or *hopper*, into the upper end of the

bolting-machine. This was a long hollow cylinder, surrounded with a sort of network of wire, resembling gauze, but of three different degrees of fineness. It was fixed in a sloping direction, and the overseer having kindly stopped the motion of the machinery, showed Harry that within the cylinder there was a framework of brushes attached to a small iron axis, which passed through its whole length. The overseer, by pulling a cord, set this iron axis again in motion; and Harry perceived that the flour, when rapidly whisked round by the brushes, was forced out through the meshes of the wire; the finest flour passing through the upper and closest division of the gauze; and so on, till nothing remained but the bran, which fell out at the lowest end of the cylinder. Each species of flour was received in separate boxes, from whence they were taken away in sacks, according to the various uses to which they were to be applied. The finest flour being employed in making the whitest sort of bread, or in pastry; the coarser in household bread; and the bran in a variety of domestic purposes.

Highly interested with what he had seen, because the patient overseer had made him comprehend it thoroughly, Harry hastened back to his mother, and was not a little astonished to find that they had been away an hour instead of half an hour.

Mrs. Frankland, however, who always hoped the best, said that they could make up for lost time, by walking quickly to the place where they were again to get into a boat.

"Quick time! March!" said Mr. Frankland, and on they marched, in as quick time as they could, till they reached the canal—a long level stripe of still water, which, as Lucy said to Harry, looked no better than a broad ditch full of water.

She saw many large boats on this canal, loaded with coals, others with goods of various sorts, and some crowded with people. To her mortification, they were to go on in one of the canal-boats; and slowly they now went, nor was there any pleasant sound of oars. Instead of being rowed by men, this boat was drawn on by a horse, which was fastened to it by a long rope, and which walking on a path on the bank, the *trackway* as they called it, tugged on with his head down, and as slowly as

his feet could step. Lucy thought he looked quite stupified, and as if he was walking in his sleep.

"Why do people make canals, papa?" said she.

He explained to her, that canals are made to supply the want of rivers, where they cease to be navigable, or in places where they do not naturally flow: he said that canals are extremely useful for carrying easily, and cheaply, heavy goods, and numbers of passengers.

Harry supposed that canals could be made only through flat countries, and in ground that was quite level. But his father told him that they could be carried through ground that is not level.

"And how do they manage," said Harry, "when they come to hills, because water cannot go up hill; we could not, I think, go safely in a boat down hill, or down steps: you know we were obliged this morning to get out before we came to that ridge, that little step in the river, the weir."

"Yes," said Lucy; "one of the boatmen said, and my own sense showed me, that it would have been very dangerous to attempt it; the boat would have pitched forward, and filled with water, and we should all have been drowned."

"Then how do people manage when they come to uneven ground?" repeated Harry. "Perhaps they do as we have done to-day, get out and walk till they have passed over the hill, and then take to the water again."

"That was the case formerly," said his father, "and is still practised in some places; for instance, in some of the fens in Lincolnshire, they not only are obliged to get out of their boats, Harry, and walk, but must carry their boats along with them, over land, or over marsh, from one place where the canal stops to another, where the ground, being nearly level, it can go on; but this is inconvenient, Harry, even to passengers; and consider what it must be where heavy loads are to be carried."

"Very inconvenient," said Harry. "Then I suppose people take great care, in the first place, to choose the most level parts of the country for their canals, and to go round the hills instead of going over them."

"True," said his father, "but sometimes they cannot go round them: what is to be done then, Harry?"

"I see nothing that can be done but to cut through them, as we saw one of the hills we passed over in our

journey, where, from the height of the banks, it appeared to have been cut down several feet, to let the road go through: the same must be done, I suppose, for canals; and where great stones or rocks come in the way, these must be blown up with gunpowder, as we saw men *blasting* away a rock, where they were making a new road. Then the rubbish, and stones, and earth, must be carried away, and a level bed left for the canal."

"*Must* is a word easily said, Harry," observed his father; "but all this digging, and blasting, and carrying away of stones and earth, is extremely tedious and expensive; so much so that it would be impracticable to have carried canals across parts of the country where they now go, if it had been necessary to make the whole bottom, or bed of the canal, upon one level. The difficulty is obviated by means of an ingenious contrivance, called a *lock*. We shall come to one on this canal soon, and then you will see how it is managed, that we pass over inequalities of ground without being obliged to get out of the boat, and without danger of its being overset."

"That is the best of it," said Lucy. "Is it quite safe, papa?"

"Quite safe, my dear: if your eyes and your ears were shut, you would not perhaps know that you were passing through a lock."

Harry determined, however, to keep his ears and eyes well open. Presently they came to two large wooden doors, which would have stopped the way across the canal had they been shut, but they were open, and flung quite back. Their boat passed on between the doors without their feeling any difference in the motion, or perceiving any change in their position. The doors were then closed behind them, and they found themselves in a sort of box, or reservoir, filled with water, just large enough to hold their boat without striking against the stonework on each side, or the wooden doors at each end. There were two doors opposite to those through which they had entered; these they found shut; but a sluice or sliding-door was immediately after their entrance drawn up; and this gradually let off the water that was in this basin, or reservoir, and the surface of the water gently sunk, sunk, sunk down, with the boat upon it, with an imperceptible motion. Lucy could, as she said, only know that they had

moved, by seeing the height above, and observing, on the stone sides of the lock, the marks of where the water had been on their entrance. They continued thus gently sinking till they came to the level of the water in the canal at the other side of the gates, through which they were now to pass. When it came to this level the men opened the gates, and the boat was drawn out, and went on without difficulty on the canal. His father bid Harry look up to the part of the canal where they had been before they entered the lock, that he might see the height from which they had sunk.

"Now, Harry," said he, "tell me how it happened, that when we first came into the lock we found the water in it upon a level with the water in the canal above, on which we had been going?"

Harry answered, that he supposed that before they had come up to the lock, men had opened the great gates, and had let the water from the canal rush into the reservoir till it rose to a level.

"Not the great gates, Harry," said his father: "the rush of the whole body of water from the canal would be too violent. Think again."

Harry thought again, and said he supposed there were small sluices on the side of the lock next the upper part of the canal, similar to those next the lower, which he had seen opened; and he supposed that these sluices had been opened before they came up to the lock, and had gradually let the water in.

His father told him that this was exactly what had happened, and reminded him of a whistle which he had heard from one of their boatmen, some time before they came to the lock, which was the signal for the man at the sluice to open it, and get ready the water for the coming boat.

Harry was much pleased with this most ingenious contrivance. "It seemed so easy," he said, "that he thought even he might have invented it."

"This is the case with almost all good inventions," said his father.

"How nicely and gently we sunk down, down, in the boat," said Lucy, "on the level water in the lock, while it was flowing out. As my father said, I am sure, if my eyes had been shut, I should not have perceived that we were going down. What a depth we sunk! What a step that would have been, Harry! for

a boat to come down: impossible, without a lock; but if you can go up and down stairs in canals—"

"Stairs! I do not know that," said Harry; "but one step, certainly."

Her father told Lucy that he had seen in Scotland, on the Caledonian canal, seven or eight locks, immediately following each other; and the people of the country called these *Neptune's stairs.*

Mr. Frankland was glad to see that Harry and Lucy had been so much pleased with the lock, as it was for the purpose of showing it to them that he had come home by the canal. Soon after passing through the lock they landed by the side of a road, where their carriage had been appointed to meet them. Mrs. Frankland rejoiced to see it ready waiting for them, and again she looked at her watch, as if afraid they should be late.

Late they certainly were, and very late; and cross, and very cross, was the old gentleman, who had been kept waiting and starving, as he said, an hour and a half beyond the regular dinner-time. Mrs. Frankland bore all he said, and all he looked, with such gentleness and good-humour, that Lucy wondered how he could continue angry. She thought, however, that he must be terribly hungry, and that when dinner came, and when he had satisfied his hunger, he would grow good-humoured again. No. At dinner he grew worse and worse. Every thing was wrong. The fish was overdone, and the venison was over-roasted; and some fault he found with every one of the many good things which Mrs. Frankland, with persuasive words recommended.

"Try this, my dear sir, or try that."

But nothing he tried would do. Mrs. Frankland looked sorry, and still kindly soothed him; but at last he said something very provoking about ladies never being punctual, and seldom thinking of their absent friends. Harry could not bear this; and his natural bashfulness, quite conquered by indignation, he called out in a loud voice,

"That is very unjust!"

The old gentleman looked up from his plate at Harry, whose face was red all over.

"Well done, my little turkey-cock!" said he, half laughing. "What have you to say or to do with the business?"

"Only that it was all my fault," said Harry.

He explained, and said that he had stayed too long looking at a mill, and talking about an undershot and overshot wheel.

"Mighty well for you and your mill," said the old gentleman, in a tone between pleasantry and reproach; "but pray, young gentleman, what was that you said about '*Very unjust?*'"

"It was unjust to say that ladies never think of their absent friends, sir," replied Harry; "because Mrs. Frankland, who is a lady, *did think* of her absent friends, and of you in particular; for she was very anxious to get home in time, lest you should be kept waiting for dinner, which she said, sir, that you do not like."

"Who does, sir!" said the old gentleman, now joining in a laugh. "But since it was all your fault, I must be satisfied, and must be obliged to Mrs. Frankland for her anxiety about me. This hare is very tender, and not over-roasted, which, considering all things, is wonderful. Mrs. Frankland, let us make up our quarrel by drinking a glass of wine together."

Mrs. Frankland's good temper and sweet smile conquered him. His forehead unwrinkled, and he became quite good-humoured, and talked of old neighbours, and of his good old friend Mr. Wedgwood again; and of the Staffordshire canal—the *Grand Trunk*, as he called it—of which the late Mr. Wedgwood was the first proposer, and which has enriched so many individuals, who had shares in the original undertaking.

After dinner, when the ladies left the room, Harry followed them, for he did not understand what was saying, about *shares in navigation*, and the interest paid upon them. While the ladies were drinking coffee, the conversation turned upon the cross old gentleman, and bore rather hardly upon him! one lady in company declaring that she thought Mrs. Frankland had been too kind to him; that, for her part, she should not, had she been in Mrs. Frankland's place, have thought herself bound to submit to his rudeness, or to bear his ill-humour. She went on to laugh at him for his epicurism.

But Mrs. Frankland stopped her. She said that she was much attached to this gentleman; that he was an

old friend of her husband's, and of his family, and had long shown them kindness, for which she felt grateful; and that the only way in which she could prove her gratitude was by trying to make him comfortable and happy in his declining years, which could not be done without bearing with his little foibles. His real benevolence, and excellent sense and information, made amends for them; his pettishness was soon over, and his kindness of heart always remained.

Lucy admired and liked Mrs. Frankland for speaking in this manner. She resolved that, when she grew up, she would be equally good-tempered, and would bear with the foibles of old friends, even if they happened to be a little cross. Above all, she resolved that she would be as steady as Mrs. Frankland, in defending them in their absence.

In the evening, after the old gentleman had taken his nap, and was sitting in his arm-chair by the fireside, he caught hold of Harry's arm, as he was passing, and said to him in a gruff. but good-natured tone—

"Tell me, little man, why you are so curious about mills? Are you to be a miller, or a millwright, pray? Or what are you to be?"

Harry, who generally understood what was said to him quite literally, answered gravely, that he believed he was not to be a millwright or a miller: that he did not yet know what he was to be; but, whatever he was to be, it could do him no harm to get all the knowledge he could. And he wished to learn all about mills, because it entertained him.

"And what do you know about them?" said the gentleman. "Can you tell me what keeps a mill going?"

"Wind keeps a windmill going," replied Harry, "and water a watermill. There are other kinds of mills, which are kept going by horses, and some are moved by men, and many by steam."

"Upon my word, you know a vast deal," said the gentleman.

"No, sir, I know very little," said Harry, bluntly, and looking ashamed, and not well pleased.

"Well, I will not affront you any more by flattering you, since I find you do not like it," said the old gentleman. "Come," added he, drawing Harry towards him, "we shall be good friends yet, you will see. I saw

you playing with my grandson at marbles yesterday. Do you know how marbles are made?"

"No, sir," said Harry, taking one out of his pocket, and looking at it. "I should like to know how they are made so very round and smooth: I should think it must be difficult."

"It is: my friend Mr. Wedgwood told me, that he had found it one of the most difficult things he had ever attempted; and when I was on the Continent I inquired how they were made."

"And how are they made, sir?" said Harry.

"First they cut a certain sort of stone into bits of any irregular shapes, no matter what, nearly the size of a common marble. These they throw into an iron mill, in which there is a number of partitions, and to each partition strong rasps are fixed, in a slanting direction: the mill is worked by water, and is turned with great swiftness: the rubbing of the stones against the rough rasps, and against each other, rounds them, and by degrees smooths and polishes them, in the same manner as the gravel becomes rounded in the bed of a river. When they are formed to the proper shape, they fall through circular holes, made in the bottom of the mill, of the right size to let them through. From Nuremberg, the town where they are made, they are brought down the river Rhine to Rotterdam, and thence sent all over Europe, to all countries and places where boys play at marbles; and where do they not? And now you know more about marbles than nine in ten of the hundreds of boys of your age, who have their pockets filled with them."

The backgammon table was now set, for the old gentleman usually played a game with Mrs. Frankland about this time every evening; but instead of going to it, he stayed talking to Harry, and telling him of various things which he had seen when he was in Holland.

"When first I went to Amsterdam," said he, "I remember, as I approached the city, counting forty-six windmills all in motion. The Dutch have long been famous millwrights, and many of the contrivances now in common use in our mills in England, were brought from Holland; for instance, one which you may have seen in your journey here. Did you take notice, that on some windmills there is a very small sort of fan-wheel, which stands out a little from the top?"

"Yes; I know what you mean, sir," said Harry.

"So do I," said Lucy. "When first I saw it, I thought it was a little windmill to frighten away birds from the corn."

"And do you now know the use of it?"

"I do," said Harry; "for my father showed me one, and explained it to me. The use of that little wheel is to turn the great sail-wheel towards the wind, by means of the wind itself, so that whichever way it blows, the mill continues to work. In those which have not this ingenious contrivance, the mill must stand still every time the wind changes, and the miller cannot set it in motion again without a great deal of trouble; he must haul round the whole top of the mill in an awkward way."

"Why! how?" said Lucy. "Do, Harry, explain the two ways in which these different windmills turn or are turned. I have some idea, but still I forget exactly how it is."

"Oh! I am sure you know," said Harry.

"Perhaps I *did* know; but go on as if I did not, begin from the beginning; first, if you please, with the awkward way with that windmill which has no little fan-wheel."

"That common mill," said Harry, "is called a post-windmill, because it is supported upon a post, which is fixed firmly at bottom, and which goes up through the middle of the inside of the wooden body or tower-part of the mill. This tower is separate from the mason-work, and from the grinding-wheels underneath; it hangs on the top of the post, and can be turned round upon it."

"This way do you mean? Like this?" said Lucy, holding her pencil upright, and hanging her thimble on its point.

"Something like it," said Harry. "But the great sail-wheel is fastened to the wooden tower, and one cannot be moved round horizontally without turning them both. Suppose the wind changes from north to south, then the tower itself must be turned, so as to bring the front of the sails to the side opposite to that on which they had stood."

"How inconvenient! And how does the miller do this? for that tower, and the sails and all, must be a great weight," said Lucy.

"He could not do it without the help of a lever," said Harry. "There is a huge ladder, which is fastened to the upper part of the tower, and which reaches from that to the ground, sloping outwards, so as to be a prop and *stay*, to keep the mill fixed in the position in which it is to stand, with the sails facing the wind. But the wind changes, and the mill must turn. Then the miller lifts up from the ground the lower end of this great ladder, which he then uses as a long handle or lever, by which he turns round the mill till the sails are again properly placed."

"So much for the post-windmill; now for the other," said Lucy; "that with the little fan-wheel, as you call it."

"That does the business cleverly, and without any trouble to miller or man. Only the top, not the whole body, of this kind of windmill is moveable. The axis of the great sail-wheel goes through this moveable top, and therefore can be shifted round horizontally along with it; this top rests on rollers, so that it can move easily on the top of the solid stone wall of the tower. Now for the little wheel."

"Ay, the little ingenious wheel," said Lucy.

"That is so placed at first, that its vanes catch the wind whenever it does not blow upon the sails of the great wheel. So, as soon as *great wheel* stops, *little wheel* sets a-going, and it sets in motion a train of wheel-work, all which I need not describe to you. I need only say, that it has the power gradually to turn the moveable top round, till it brings great wheel with its sails facing the wind; then great wheel sets a-going; and little wheel by this time, having worked away from the wind, stops. Its business is done, and it rests till it is wanted. When the wind again changes so as to blow on its vanes, then it sets off again, and works the great wheel round to the right point, and so on continually."

"Very well, you understand it, I see," said the old gentleman, "if I may say that much without your thinking that I mean to flatter you."

Harry smiled. "But," said he, "there is a thing I do not at all understand about windmills. I saw some standing still, while others nearly in the same situation were going, with the same wind; I was thinking what the reason of this could be; and I suppose that there must be something different in the way in which the

vanes or sails themselves are sloped, or *set*, I believe I should call it."

"You think rightly, I believe," said the old gentleman. "I have a friend in France, a scientific man, who made a windmill, which continued working when all the other windmills in the neighbourhood remained motionless. The common people used to gather round and stare at it, and say that it went by enchantment, for they could not conceive how it could go with less wind than their own; but this arose from the judicious position of the vanes, which had been placed so that the wind should act upon them with the greatest possible force."

"I wish I knew that judicious position," said Harry; "I have often tried to discover it in making little windmills, but I could only place the sails by guess. I should like to know the rule and the reason, and the best possible way."

"And I should be very glad if I could tell you all this, my dear; but that is beyond me. Learned men have thought and written much upon this very question; but I am not a man of science, or a mathematician, therefore I cannot explain it to you. I can describe only the things which I have seen, and which I understand."

He then gave Harry an account of several things he had seen in Amsterdam. Harry knew that this city is built upon piles. Lucy said she recollected reading the number of these piles, which was prodigious.

Harry asked whether any of them had given way, or whether the houses stood upright upon them.

"No," said the old gentleman; "the first idea I had when I entered Amsterdam was, that many of the houses were tumbling down, they were so much out of the perpendicular line; but still they do not fall."

Harry was going to ask the reason of this, but another question occurred to his mind, which he was afraid he should forget if he did not ask it first. "Pray, sir," said he, "do you know if the Dutch are acquainted with the use of steam-engines?"

"Oh! yes, certainly."

"Then why," said Harry, "do not they use steam instead of wind, to keep their mills at work?"

"Why should they?" said the old gentleman.

"Because," said Harry, "wind is uncertain; they cannot have it when they please; and if they have not wind,

their mills must stand still. If there is a storm, they cannot make the wind less or more, just as they want more or less force or quickness; but we can manage steam as we please, at all times of the year, and in all weather."

"Very true, my little mechanic," said the gentleman; "the Dutch are now beginning to use steam-engines; and what is more—"

What more he said Lucy was in no condition at this moment to hear, for on the scattering of the snuff which he threw from his fingers, she was seized with a fit of sneezing, that seemed as if it would never end. When she recovered, she heard the old gentleman speaking of the embankments, or high and broad banks, which the Dutch have been obliged to raise to protect the country from inundations These embankments are secured chiefly by mats, fastened down by willows, which are twisted together, and which remain after the mats decay, and thus form the best barrier against the force of the sea.

"Willows!" said she, "such yielding things, which I can bend with the least touch; can they withstand the whole force of the sea?"

"Yes, exactly for that reason," said the old gentleman, "because they do not resist; just as you may have seen the most yielding manner do best against the torrent of anger, and the gentlest of women subdue the most violent-tempered man."

Lucy smiled; she was always ready for a simile, but she liked this extremely, and was pleased with its particular application. Harry's heart now opened He drew close to the elbow of the arm-chair, from which he had before kept at a certain distance, and he began to use his privilege of asking questions freely, which he had till now done only with great reserve. His mother soon called him away, and advised him and Lucy to go to bed, as they were to set off early the next morning to pursue their journey. They were sorry to go, and everybody seemed sorry that they were going. The old gentleman asked which road they intended to take; and when Harry's father answered, by Coalbrook Dale, he said that he was very glad of that, for the sake of his young friends.

"Perhaps I shall not be up when you set off in the morning," said he, "so shake hands, young gentleman,

and fare you well. It is happy for you that, so early in life, you have acquired such a desire for knowledge. To-morrow you will see—"

Mr. Frankland interrupted him, "My dear sir, do not tell him *what* he will see. Leave him the pleasure of surprise."

"GOOD-BY." It was come to that melancholy word; and as Lucy put her head out of the carriage window to say the last good-by to Mr. and Mrs. Frankland, who were on the steps at the hall door, shutters opened in a bedchamber above, the sash was thrown up, and the old gentleman put out his head, and repeated "Good-by! good-by! and a good journey to you."

"Thank you, thank you, sir; and pray shut the window, or you will catch cold," said Lucy. "He was very kind to you, Harry, after all," continued she, as they drove away; "and told you a great many entertaining and useful things; and at last I liked him very well, though he did take so much snuff. And though he was a little cross yesterday at dinner, he made up for it afterward. I do believe, Harry, that he loves Mrs. Frankland in his heart."

"Who can help it!" said Harry.

"I wish," said Lucy, "that when I grow up I may be such a woman."

"I wish you may," said Harry, in a tone that sounded gruff, because it was as much as he could do to command his voice to speak at all, he was so sorry to part with these kind friends. Lucy indulged him in his taciturnity, and began to examine a little red-morocco memorandum book which Mrs. Frankland had put into her hand at parting, and which she had held till now unopened. On turning over the leaves of this book, she found some of the pages filled with close writing.

"Dear, good Mrs. Frankland!" exclaimed Lucy. "Look, mamma, she has written all this for us, with her own hand: and what do you think it is?"

"'The Juvenile Gardener's Calendar, dedicated to Harry and Lucy, by their sincere friend, E. Frankland.'

"'Spring,' 'Summer,' 'Autumn,' 'Winter,' all in four little pages," said Lucy. "I am always puzzled with the long directions in gardening books, about heaps of

things too, which I have not; but here, I see, are only such flowers and plants as we have, or ought to have, in our gardens, Harry; and," continued she, after looking over the calendar, "it tells me exactly all I wanted to know, about the times and seasons for planting and transplanting, and sowing seeds, and how to have successions of pretty flowers. I must read it to you, Harry." She read, and when she had finished, he joined in her delight, at finding that it contained all, and no more than they wanted.

"And you read it much better, Lucy, than you *sometimes* read writing," said Harry.

"Because," said Lucy, "this is much plainer than writing is *sometimes*. Do you recollect, Harry, how I stumbled in trying to read to mamma your translation?"

"Yes, I knew you wanted to read it particularly well," said Harry, "but you *boggled* terribly: it made me very hot."

"Not hotter than I was," said Lucy. "I wanted to read it particularly well indeed."

"That was the very reason you could not," said Harry, "you were too anxious and frightened."

"But what frightened me was, that I could not make out the writing. I knew I was making nonsense of what I was reading, and I could not help it. Since you have set up to write a running hand like papa's, you run all your letters into one another, so that at last, in some of your words, there is not a single plain letter."

"Ah! my dear! I can show you in that very translation several—"

"Possibly; but then you make three kinds of *r*s, and when I have learned to know one of them, then comes the other, quite different; and all your *m*s, and *n*s, and *u*s, and *v*s, are so alike, no human creature in a hurry can tell them asunder; and you never cross your *t*s, so how can I tell them from *l*s."

"But I do dot my *i*s," said Harry.

"Yes, you do; but you never put the dots over the right letter; I can never guess to what heads the hats belong; and then, worse than all, you half scratch out, and half write over, and half turn one letter into another, and then repent, and leave it no letter at all. But all this I could bear, if you did not make vulgar flourishes."

"Oh! Lucy, be just; I have left off flourishing, you

must acknowledge, ever since you told me it was vulgar. I have never flourished since that day."

"But that day was only last Tuesday," said Lucy.

"I do not know whether it was Tuesday or Wednesday," replied Harry; "but I know it was the day you read, or could not read, my writing to mamma, and I have never flourished since."

"Poor Harry! I beg your pardon for reading your translation so badly," said Lucy; "the next I will read better, if I can."

"The next I will write better, if I can," said Harry. "Let me look again: how does Mrs. Frankland make her writing so plain?"

"And so pretty too," said Lucy. "It looks pretty because it is so even and straight; and it is distinct, because—let me see—she always makes the same letters the same way, that is one good thing; for then I know them again when I meet with them; and she leaves a little space between her words, so that we may see they are separate words; and she finishes each letter, and does not make her *m*s and *n*s so very much alike that people cannot tell the difference. The little *e*s too are a little different from the *i*s."

"Very little," said Harry; "if I hide the other letters, I defy you, Mrs. Lucy, to tell even Mrs. Frankland's *i* from her *e*."

"But look at the difference, Harry; the *e* is a little open at top; or, at worst, I know the *i* by the dot over it. Look, the hat is always on the right head, and I know the head by the hat."

"A woman's way, indeed, of knowing a head!" said Harry, laughing.

"Oh, Harry! when you come to laughing at women," said Lucy, "I know you have nothing else to say."

"Yes, I have," replied Harry. "Since you are so fond of reading Mrs. Frankland's writing, here is a little bit more for you; here is a page in your book which you have not read."

Lucy took the book, but was disappointed when she saw this page was only a catalogue of the botanical names of the flowers and shrubs mentioned in the Juvenile Gardener's Calendar. She did not know the use, she said, of calling flowers and shrubs by Latin names, when they have good enough English names, by which all people may know them, if they please. She

confessed, that the only thing she had not liked in all that Mrs. Frankland ever did or said, was her having that day, in the garden, always told the Latin names of the flowers after the English.

"Harry, I know you think as I do, that you thought so at the time; that made me dislike it the more, because I was afraid you would think it was—you know what."

"I know," said Harry; "and I did not like it, I own."

"We will ask mamma," said Lucy.

They had been all this time talking to one another on their own side of the carriage, and their father and mother, on theirs, were conversing on something perhaps as interesting to themselves. It was necessary to wait for a pause. At the first which occurred the case was laid before them, Lucy stating it with some hesitation, and ending by saying,

"Am I wrong, father, to think it was pedantic? Am I wrong, mamma, to say any thing about it?"

"Not at all wrong to speak your opinion freely to us, my dear," said her mother.

"You would be foolish," said her father, "if you blamed without inquiring whether you were right or wrong; but you would be wrong if you spoke to any stranger of a fault that you saw, or thought you saw, in those who had been kind to you."

"You do not think it was pedantic, then, mamma?"

"No, my dear, I do not; but before we can understand one another, we must settle what we mean by pedantic. What do you mean?"

Lucy said she knew what she meant, but she could not exactly describe it. She turned to Harry. First, he said, that it was talking Greek or Latin in the wrong place; he added, that it was trying to show that we had any sort of learning that other people had not. But this, Lucy thought, was rather vanity or ostentation than pedantry. They had heard people call things pedantic which they did not think were so; for instance, a boy had once said that Harry himself was a pedant for talking of the siege of Syracuse, and of the machines used there, because the boy knew nothing about them, and disliked reading.

"Then you perceive," said his mother, "that the meaning of the word varies with the different degrees of knowledge of those who use it. I remember when

it was thought pedantic for a woman to talk of some books which are now the subject of common conversation. Sometimes oldfashioned learning, and sometimes useless learning, is called pedantry; and it is generally thought pedantic to produce any kind of learning that is so unusual that it is not likely that the company is acquainted with it, or can be pleased by it. In short, pedantry may be said to be an ill-timed parade of knowledge."

"To go back to Mrs. Frankland, mamma," said Lucy: "she knew that we were not acquainted with those Latin names."

"Yes, but she did not consider you as *company*. She did not display her knowledge to excite your admiration; she used those names in speaking to you, because she thought it might be useful to you to learn them. The knowledge of the botanical names of plants is not now unusual; most people we meet with are acquainted with them."

"I did not know that," said Lucy. "And now I recollect, mamma, when Mrs. Frankland was talking of plants to the artificial-flower woman, who did not seem to know any thing about the matter, she called them only by their common English names; therefore, I am sure, she told the Latin names to us, because, as you say, she thought it would be of use to us. If she had wanted to be admired for her learning, she would have displayed it in company. So it is proved, Harry, that she was not pedantic, and I am very glad of it."

"But still," said Harry, who did not seem quite satisfied, "remember what mamma said, that useless learning is pedantry."

"Then the question is, whether this be useless learning or not," said his father.

"That is the very bottom of the question to which I want to get," said Harry. "What is the use of knowing all those long Latin names, when people may know the plants they are talking of as well by their own English names?"

"They may know them, and describe them as well, to English people, but not to foreigners," said his father. "Most well-educated foreigners, French, Spaniards, Germans, Italians, Danes, or Swedes, understand Latin, therefore it is a sort of universal language in which botanists, and persons of science, can make

themselves understood by each other. In all books of botany the Latin is given along with the common name; and then the description of the plant to which this name refers can be applied by people in different countries. I have a friend at Paris who could not understand what was meant by a cowslip, because in French there is no distinguishing name for cowslip; it goes under the general word for primroses, *primevere*."

"Yet a cowslip and a primrose are very different," said Lucy.

"But," said her father, "if this French lady had been acquainted with the botanic name, she would have known the difference the moment it was mentioned, and the deficiency in the French vocabulary would have been rectified. I remember hearing a French lady talking to a gentleman about the beautiful laurier rose: the gentleman understood French, but he happened never to have seen a laurier rose in France, therefore he could not understand what she meant. She described it, but still he mistook it for a rhododendron; at last somebody mentioned its botanic name, *Nerium oleander*, and the moment the gentleman heard this Latin name he understood what was meant, and he knew it was the common oleander which he had often seen in English greenhouses."

Harry now understood the use of learning the Latin botanic names, and he was satisfied.

"Remember, my dear Harry," added his mother, "that I mean no more than that it is useful as a language, and as a means of acquiring knowledge."

Lucy said that she would learn by heart all the botanic names of the common flowers in the garden calendar, which Mrs. Frankland had been so kind as to write in her pocket-book; and she begged Harry to tell her whether many of them had any particular meaning, like those two which she had been told, *Hydrangea, the water lover*, or *Agapanthus, the beautiful*, because she thought she could then learn them more quickly by heart, and remember them better.

Harry said that he would if he could, but that he would rather do it at another time. He wanted to look at a broad-wheeled wagon which was coming down the hill. And while he watched the shape and motion of the wheels, and asked his father some questions concerning them, Lucy was pitying the poor dog which was

chained underneath the wagon, and which, as he waddled along, apparently half dragged by the neck, looked very mournful. She was told that his use was to guard the wagon, and that his being chained to it secured his always being near it. She wished very much that the man could be persuaded to loose him; a faithful dog, she thought, would guard his master's goods without being chained. Her mother observed, that it would be useless to talk sentiment to an English wagoner. Lucy wished that she had some money, that she might give it to buy this dog from his master, and set him free. Her mother told her that even supposing she could buy this dog, the man would get another, and this dog would not perhaps be better off, as he might not find anybody to feed him: "You know, my dear Lucy, we could not take him with us. What should we do for the next dog we meet under the next wagon!"

Lucy saw the impossibility of freeing them all, and sighed. Her mother was glad to see that she had such humane feelings for animals, but said, "There is much we must bear to see in this life that we cannot remedy; all we can do is, to take as good care as possible of those creatures of which we have the charge."

Lucy blushed: "I will take care not to forget to give poor Dash water when I have him again, mamma. I recollect one day—"

Here she was interrupted by Harry, exclaiming, "Father! pray look out of the window this instant! Do you see that streak of black powder in the track of the wagon, papa? I saw it dribbling from a barrel. Is it not gunpowder? May I get out and look?"

He spoke as fast as he could utter the words, and his father instantly called to the wagoner, stopped the carriage, and jumped out, Harry following him. It was gunpowder. They ran after the wagoner, who either did not hear or would not stop. When they overtook him, and showed him the gunpowder running out of the barrel, he, being a sulky fellow, was very angry with the barrel, and with the man who packed it, and with the man to whom it was going, and with everybody but himself. He had no clear idea of the danger he had run, till Harry's father told him that he had some years before known a wagon to be blown to pieces, and the men and horses killed, by just such an accident. Some gunpowder had been shaken out of a barrel in the

wagon, and had taken fire, as it is supposed, from a spark struck from a flint in the road. This, communicating with the gunpowder, had blown up the whole. The wagoner scarcely credited the story, till he heard the name of the hill down which the wagon had been going, and then, as Harry observed, without any further question, he believed it to be true. So it is, that ignorant people believe or disbelieve without any reasonable grounds. They stayed to see the barrel well packed, and safely stowed. Some of the passengers, who were sitting within the canvass roof of the wagon, and who had looked out and listened, now expressed much gratitude, and said they might have lost their lives but for this timely discovery of danger. The wagoner then grew warmer in his thanks, and, as he was repacking the barrel, said in his Somersetshire tone to Harry,

"Master, you've done uz a mortal good turn, I finds, and if so be it was in my power to give you a lift any ways, I'd not be behind, you'd zee; but the likes of I can do little for the likes of you gem'men."

Harry thanked him; he wanted nothing, he said, but he was glad that he and his wagon were safe.

"How well it was, father," said Harry, as they walked back together to the carriage, "that I saw the gunpowder running out, and recollected what you had told me about the blowing up of the wagon."

"Yes," said his father, "you see how useful it is to observe what passes before your eyes, and to recollect what you know at the right time."

When Lucy heard what had passed, after rejoicing that wagon and wagoner were safe, she regretted that, when the man offered to do Harry a good turn, he had not said a word for the dog.

"I forgot the dog," cried Harry. "Father, will you stay for me three minutes? I will run and speak for the dog."

His father smiled, and back he ran. What he said, or in what words the wagoner replied, we cannot tell, for Harry never could remember either the words he used, or those said to him; but the result was, as he informed Lucy, that the dog Lion was unchained, that the wagoner promised that Lion should have liberty to run after him by day, and that he should be chained only by night.

Lucy was proud of her brother's share of this affair,

and, as was ever her custom when she was happy, she went on talking of every thing she could think of, and of all that she saw upon the road: while Harry, according to his custom when he was well pleased with himself, and particularly happy, was quite silent. After Lucy had exhausted every thing she could say, she perceived Harry's silence.

"What are you thinking of, Harry? are you still thinking of Lion and the wagoner?" said she.

"Not I, for there is nothing more to be done about them," said Harry. "I am considering what that very bright thing can be which I see out yonder, sparkling in the sunshine."

"I see it," said Lucy, "it looks like a monstrous diamond, twinkling between the trees. What is it, papa? look at it."

Her father thought it was the reflection of light from some weathercock, or polished globe, on the top of a building. As they approached nearer, they saw it was from the glass roof of a conservatory.

"Reflection of light!" said Lucy; "what do you mean, papa, by the reflection of light? and what is the difference between reflection and refraction, of which I have heard?"

Her father answered, "When the rays of light are thrown back from the surface of any polished substance on which they strike, for instance, from a polished piece of metal, or of glass, they are said to be *reflected*. When the rays pass *through* any transparent body, and, in doing so, are turned from their direct course, they are said to be *refracted*, and this light is called *refracted* light."

"Do you recollect, Lucy," said Harry, "yesterday in the boat, you observed that the oar in the water looked as if it was broken? That was because you saw it through the water. Mr. Frankland told you that was the effect of refraction."

"I remember," said Lucy, "that he told me so, and that I did not understand at the time what he meant. I was ashamed to ask him more about it, and afterward I forgot it; but you, Harry, can explain it to me, cannot you?"

"Indeed, I cannot," said Harry.

"But, papa, will you be so good as to make us understand it?"

"My dear, I cannot be so good as to make you understand it yet, till you have more knowledge: I am glad, however, Lucy, that you observed the appearance of the oar in the water, and that you wish to know the reason of what you saw. Seemingly slight observations of this sort lead to important discoveries."

"Do they, indeed, papa," said Lucy.

"Yes; but often observations such as these, though they might lead to great discoveries if pursued, remain hundreds of years useless, because people do not try to find out the reason of what they have seen. As long ago as the time of Aristotle, which is above two thousand years, among other questions in his works on natural history, he asks, why a stick appears bent when it is held obliquely in water? This question was never rightly answered till about four hundred years afterward, by Ptolemy. The fame of several great philosophers, among the moderns, rests upon their discoveries of the rules or laws for measuring that refraction of light, on which the appearance of the bent stick in water depends. And not till the time of our great Newton was the whole satisfactorily explained, or all the knowledge obtained to which it has led. He, by pursuing this and other seemingly slight observations, and by trying experiments carefully, to find out the cause of what he had observed, made his great discoveries of those properties and laws of light, which we call the laws of reflection and refraction. Even from considering the colours on a soap-bubble, which many others had observed before him, but of which they had made no use, he was led to some of the most important conclusions respecting vision and colours."

But here all philosophical conversation ceased, interrupted by the sound of the horn of a mailcoach. Harry and Lucy quickly darted their heads out of the window; for though oftentimes seen, Lucy never willingly missed the passing of a coach, stage, or mail. This was, as Harry guessed, the royal mail, with its guard behind, the scarlet man with the gold-laced hat, blowing the authoritative trumpet to clear the road. Proud as a king on his throne sat the many-caped, many-cravatted coachman on his box, with his four fine horses even in hand, which kept on in full trot, regardless of the load behind—the whip idle in the master's hand, except that once he flung out the long lash with a light touch, to re-

mind one careless horse that he must draw fairly, and to bring him into true trotting time. As they passed, Lucy admired the horses much, but the harness more.

"Nice!" said she, "and nicer than any gentleman's harness. Bright brass rings standing upon the horses' foreheads, with twinkling gimmals glittering in the sun."

Regardless of the harness and the twinkling gimmals, Harry had eyes only for the horses.

"What fine creatures! and how they go! Oh, father! look! how they turn the corner," cried Harry, leaning out of the carriage, to watch them till they were quite out of sight.

The road for the rest of this stage was, as Lucy observed, a stupid straight line: she could find nothing to do but to count the carriages they met in the last five miles. Her father told her that on the Bath road he had once met eleven stagecoaches in five miles. But on this road, she met, in five miles, only one heavy-laden wagon, and twelve coal-carts. Harry wondered that she continued still looking out of the window, when there was nothing to be seen but coal-carts: she said she had a reason for this, and he left her to take her own time to tell it, which did not happen this stage.

"HARRY! do you remember that the old gentleman told us last night," said Lucy, "that we should be *surprised* before this day's journey should be over!"

"So he did," said Harry; "but I have been so happy all day, that I never thought of it till this minute."

"I have been very happy too," said Lucy, "but I have thought of it sometimes. And now that dinner is over, and that evening is coming on, it is time to think about it. I wonder, Harry, what it can be."

Lucy was standing in the parlour of the inn where they had dined, and she looked all around the room, and then out of the window, as she spoke.

"There is nothing surprising here, I am sure," said she. "But I heard papa order that the horses should not be put to yet, not for two hours. What can be the reason of that, Harry?"

"We are to walk through some park near this town, I believe," said Harry, "and the carriage is to meet us

at the farthest gate, and we are to see some house. Come! Come Lucy! Papa is calling to us to follow him."

Lucy followed with great alacrity, certain that they were now going to be surprised. But they walked up an avenue of beech-trees, and reached the house without meeting with any thing surprising; and Lucy was disappointed when she found that her father and mother came to this house only to look at some pictures. Neither Harry nor Lucy had yet any taste for pictures, and their mother therefore advised them to divert themselves by running about the pleasure-grounds, which amusement they were permitted to enjoy, upon her answering for them that they would not touch any of the flowers or shrubs. First they went all through the flower-gardens, then through the park, and by the river side, and up again through a wood on the banks, till the red light of sunset, which they saw on the stems of the trees, warned them to return from whence they came. They were afraid of being too late, and of keeping their father and mother waiting; but luckily they met the wood-ranger going home from his work, and he showed them a path which took them the shortest way to the house. Instead of being too late, they found that they need not have run so fast, for their father and mother had not yet finished looking at the pictures.

"Let us sit down then, and cool ourselves quietly," said Lucy. "Harry, only think of papa and mamma having been all this long time looking at pictures! How tired I should have been if I had been standing all this while, with my neck bent back, staring up at them. Harry, do you think that, when we grow up, and set out upon our travels, that we shall ever be so fond of pictures as to stand looking at them so long?"

"Perhaps we may," said Harry, "though we do not care about them now. I remember, some time ago, I never thought of looking at prints, except of machines; but ever since the day I saw the prints in Don Quixote, I have grown fond of them."

"Yes; and how happy we were together," said Lucy, "looking over the prints in Pyne's Microcosm."

"True, I forgot them," said Harry. "I always liked those, because they are so like things and people we see every day."

"And the prints in the Arabian Tales," said Lucy,

"though they are not like things we see every day, or any day, or that we can ever see in reality; you like those, do not you, Harry!"

"I do," said Harry, "some of them."

"Some of them," repeated Lucy. "Very right, so do I. Those that are like my ideas of what the sultans, and viziers, and Fatimas, and their turbans, and Coge Hassans might be. But some others I do not like, such as Aladdin's genius of the lamp, and the African magician, because they do not come up to my imagination of them. Harry, do describe to me your image of the African magician."

It was a difficult task, and Harry was glad to be relieved from it by his father's calling to him, to desire he would see if the carriage was come to the park gate. It was there waiting, and by the time they got into it the sun was set, and it was growing dusk. By the time that they reached the end of the next stage, and had drunk tea, it was quite dark. They were, however, to go on another stage this night. Lucy, who did not much like travelling in the dark, observed, as her mother was getting into the carriage, that the coach-lamps were not lighted.

"Never mind, my dear," said her father, "we shall have light enough soon."

"Soon! Oh no, papa, begging your pardon," cried Lucy, "there will be no moonlight these two hours. I can show you when the moon will rise by my new pocket-book, papa."

"Very likely, my dear," said her father; "but, Lucy, do not stand talking on the step of the carriage."

At the moment when her father was giving her this advice, one of the horses was started by a light, and, giving a sudden jerk to the carriage, Lucy was thrown from the step backward, and must have fallen under the wheel, but that her father caught her in his arms, and set her upright again. Into the carriage she went directly, and while yet trembling with the fright, her father repeated his advice.

"While you live, child, never again stand in that manner on the step of a carriage, without holding by something. I assure you, that you put yourself into much greater danger at that moment than any you are likely to meet with from the darkness of this night."

Lucy hoped that her father did not think that she was

a coward, and after some minutes' silent submission she expressed this hope, and began to defend her character for courage by reminding Harry of all the instances she could recollect of her *never* having been afraid in a carriage. Harry said nothing. "I cannot see your face, Harry. I hope you are agreeing with me."

"No, I am laughing; for I think you are a little afraid at this minute. I feel you squeezing close to me, because we are going down the hill."

"Think and talk, then, of something else," said her mother; "and do not tell Lucy she is a coward, or you will make her one. Lucy, my dear, there is no danger; but if there were ever so much, you cannot alter it."

"No, mamma; only I wish he would not go quite so fast," said Lucy. "Would you speak to him?"

"No, I cannot teach the postillion to drive; can you, Lucy?"

"No, indeed, mamma," said Lucy, laughing, or trying to laugh.

"Then we had better let him follow his own business, which he understands, and which we do not."

"Very well, mamma; I know you are right, and that there is no danger now. We are down the hill, I feel, and it is all over nicely. But, mamma, suppose there was danger, and that the horses were really what is called running away, what would you do?"

"Sit still. The only thing which would not increase my danger," answered her mother.

"Could not you get out, mamma?" said Lucy.

"I could, perhaps, but I would not attempt it; because I know it is the most hazardous thing that could be done," said her mother.

"Yes," said Lucy's father, "I believe that more lives have been lost, and more limbs broken, by persons attempting to get out of carriages when the horses were running away, than ever were lost by overturns. All who have had experience can tell you, that the best thing you can do is to stay quietly in the carriage till the horses stop or are stopped. If you make any noise, or scream, or call to the person who is driving, you endanger yourself more, because you distract his attention, and you may be sure that he is doing the best he can, because he is probably as fond of his life as you are of yours. And as to driving, probably *his* best is better than *your* best."

"Certainly, papa; but if—" said Lucy, and there she paused.

"If what?"

"I am not sure whether it is right to say it, papa; but I have heard that coachmen and postillions are sometimes drunk; and *if* he was drunk, he would not know how to drive."

"And do you think that his being drunk would make you know how to drive?" said her father.

Lucy laughed again, because Harry laughed.

"But, papa, I should know better than he did, if he had lost all sense."

"True; but I would not advise you, as a little girl, or even if you were a woman I should not advise you, to attempt to direct or argue with a drunken man; for, besides the danger of his giving some rude answer, either the coachman would be too drunk to understand any thing, or he would not; as long as he could understand any thing, it is probable he would understand what he habitually knows best,—how to drive. If he be so far intoxicated as not to know how to do that, he would be still less able to comprehend your reasons or directions, supposing them to be ever so good."

"Very true," said Lucy. She declared that she never should think of talking to a drunken coachman or postillion, but she hoped that she never should be driven by one.

In which hope her mother joined her. "Lucy, my dear," said she, "when I was young I was afraid in a carriage, and I will tell you how I was cured."

"How, mamma?"

"I was cured of my fear for myself by a greater fear for another person. I used to be sent out airing with a lady who had lost the use of her limbs, and I was so much afraid for her that it took my attention away from myself. She was very cowardly; I was taken up in quieting her apprehensions; and I saw, that nine times in ten, when she was alarmed, there was no cause for fear. This encouraged me the next time, and so on: besides, the feeling that if there were any danger I must act for her, was a motive to me to keep my senses and presence of mind."

"As to that last," said Lucy, "I think, at least I fear, that it would have had a contrary effect upon me, and

that I should have been ten times more afraid with the helpless person in the carriage."

"No," said Harry, "I think I should have felt as my mother did."

"What stops us? What is the matter?" said Lucy.

"Matter! nothing in the world, my dear," said Harry, laughing; "only we are stopping till the turnpike-gate is opened, and till this old man with a lantern has fumbled the key into the lock."

Lucy joined in his laugh, and said afterward, "Laughing is very good for curing people of being afraid foolishly; for when you laugh, Harry, I know that there is no danger, or you could not be so merry. And now—it is very extraordinary—but I am no more afraid than you are, Harry. I will prove it to you. I will think of any thing you please. I can *cap* verses with you, if you will."

"No, thank you, not yet. I do not know enough to cap with you yet, my dear. The little that I know is from Shakspeare, and that is blank verse, which will not do for capping."

"But it will do for repeating," said Lucy; "and I wish you would repeat some of the quarrel of Brutus and Cassius, which we read together."

"I will try," said Harry; "where shall I begin?"

"Begin," said Lucy, "with Brutus's speech."

> "What! shall one of us,
> That struck the foremost man of all this world,
> But for supporting robbers, shall we now
> Contaminate our fingers with base bribes?"

Harry repeated this as if he liked it, and went on through all Brutus's part of the quarrel. He said he could not forget any of this, because he felt it. He admired Brutus, and Lucy pitied Cassius. His mother observed that he liked dramatic poetry better than descriptive. Lucy, however, thought some descriptive poetry was beautiful, and repeated to him the description of Queen Mab and her chariot of the hazelnut, made by the joiner-squirrel, "time out of mind the fairies' coachmaker." This Harry liked well. Also some of the fairies in the "Midsummer Night's Dream," who "light their tapers at the fiery glow-worms' eyes." And Harry admired Ariel in the "Tempest," whose business it is—

——"To tread the ooze of the salt deep;
To run upon the sharp wind of the north;
To dive into the fire, or ride on the curled clouds,
Or put a girdle round the earth in forty minutes."

And he could conceive the delicate Ariel's pleasure in killing the canker in the rosebuds, flying on the bat's back, or lying in a cowslip's bell. But for Pope's elegant Ariel, and the "fifty chosen nymphs of special note," he cared but little. He well knew that his mother admired them, but he was too sturdily honest to affect admiration which he did not feel. He thought it was his fault. His mother told him that perhaps he would like them hereafter, and that in the meanwhile he need not despair of his own taste for poetry.

Harry observed how much more easy he found it to learn lines which he understood, than to get by heart lists of names. He said that he recollected having read in Baron Trenck's Life, that when the King of Prussia wanted to try Trenck's memory, he gave him to learn by rote fifty strange names of soldiers in a regiment. Trenck learned them quickly.

"I am glad," said Harry, "that I was not in his place, for his majesty would have thought me quite a dunce, and would have decided that I had no memory. It is much more difficult to learn nonsense than sense," continued Harry: "there is something in sense to help one out."

"Unless it be droll nonsense," said Lucy; "but when it is droll, the diversion helps me to remember."

Harry doubted even this.

Their father said he would, if they liked it, try the experiment, by repeating for them some sentences of droll nonsense, which were put together by Mr. Foote, a humorous writer, for the purpose of trying the memory of a man who boasted that he could learn any thing by rote on once hearing it.

"Oh! do let us hear it," cried Lucy; "and try us."

"Let us hear it," said Harry; "but I am sure I shall not be able to learn it."

"It will be no great loss if you do not," said his father.

"Now, Lucy, pray sit still and listen," said Harry.

But Harry's power of attention, which he had prepared himself to exert to the utmost, was set completely at defiance when his father, as fast as he could utter the

words, repeated the following nonsense, abruptly beginning with—

"So she went into the garden to cut a cabbage-leaf, to make an apple-pie; and at the same time a great she-bear coming up the street, pops its head into the shop. 'What! no soap?' So he died, and she very imprudently married the barber; and there were present the Picninnies, and the Joblillies, and the Garyulies, and the grand Panjandrum himself, with the little round button at top; and they all fell to playing the game of catch as catch can, till the gunpowder ran out at the heels of their boots."

"Gunpowder at the heels of their boots! horrible nonsense!" cried Harry; while Lucy, rolling with laughter, and laughing the more at Harry's indignation, only wished it was not dark, that she might see his face.

"Well, can either of you remember or repeat any of this?" said their mother.

Lucy said, that if it had not been for the grand Panjandrum, she was almost sure she should have been able to say it; but she was so much surprised by meeting the grand Panjandrum himself again, and so diverted by his little round button at top, that she could think of nothing else; besides, laughing hindered her from hearing the names of all the company who were present at the barber's marriage: but she perfectly well remembered the Picninnies; and she knew why she did, because their name was something like *piccanini*; and this word had been fixed in her head by a droll anecdote she had heard of a negro boy, who, when he was to tell his master that Mr. Gosling had called upon him one morning, and could not recollect his name, said he knew the gentleman was a Mr. *Goose-piccanini*.

"So you see, Lucy," said her father, "that even with you, who seem to be yourself one of the numerous family of the Piccaninies, or of the Goose-piccaninies, there is always some connexion of ideas, or sounds, which helps to fix even nonsense in the memory."

"Papa, will you be so very good as to repeat it once more. Now, Harry, once more let us try."

"I would rather learn a Greek verb," said Harry. "There is some sense in that. Papa, could you repeat one?"

"I *could*, son, but I will not now," said his father; "let your sister divert herself with the grand Panjandrum, and do not be too grand yourself, Harry. It is sweet

to talk nonsense in season. Always sense would make Jack a dull boy."*

The grand Panjandrum was repeated once more; and this time Harry did his best, and remembered what she went into the garden to cut for an apple-pie; and he mastered the great she-bear, and the no soap, but for want of knowing *who* died, he never got cleverly to the marriage with the barber. But Lucy, less troubled concerning the nominative case, went on merrily, "and she very imprudently married the barber." But just as Lucy was triumphantly naming the company present, and had got to the Joblillies, Harry, whose attention was not so wholly absorbed as to have no eyes for outward nature, exclaimed—

"Father! father!—Look! Look! out of this window. A fire! a fire! a terrible fire it must be. The whole sky yonder red with it."

"Terrible!" said Lucy, looking out. "It must be a town on fire."

"Father!" repeated Harry, much astonished by his father's silence and composure, "do not you see it!"

"I do," said his father, "but it is not a town on fire. You will see what it is presently."

A dead silence ensued, and the grand Panjandrum was forgotten, as though he had never existed. They drove on, Harry stretching out of one window, and Lucy leaning out of the other, while her mother held her fast, lest the door should open.

"Harry, what do you see! I see fires, flames!—great sparks flying up against the sky. Now I see, I do see, mamma, a house burning—there, there, mamma, at a distance, flames coming out at the top!"

"On my side, I see flames coming out of the ground," said Harry.

Lucy rushed tumbling over to her brother's side of the carriage, bidding him to look out at the house burning.

"Fires indeed! the whole country is on fire," said Lucy.

"I suppose they are burning the grass, or a wood,"

* Future commentators will observe, that this alludes to the ancient British adage,

"All work and no play makes Jack a dull boy,
All play and no work makes Jack a mere toy."

said Harry, endeavouring to regain his wonted composure, and to make sense of it; "but certainly there is a house on fire, father! flames red as blood bursting from the top!"

"And we are coming nearer and nearer every instant," cried Lucy; "the road, I see, is going through the middle of these fires; Oh, father! mother! will you call to the man, he must be going wrong."

"He is going quite right, my dear," said her mother: "keep yourself quiet, there is no danger, as you may see by our not being alarmed for you or for ourselves."

These words, calmly pronounced, tranquillized Lucy, and Harry determined to wait the event, and not utter another word, whatever he might see. He was quite certain, by his father's composure, that there was no danger, either for themselves or for other people; but this security left his mind more at liberty to feel curiosity, and very curious he was to know what was coming, how it would end, and, above all, how it would be accounted for.

They were driving now along a raised road, with fires on each side of them: flames seemed to burst from the ground at intervals of a few yards. Their deep red colour and pointed shape appeared against the dark night, far and wide as the eye could reach. The fires near the road made it as light as day.

"My father might well say we should have light enough," thought Harry.

"I wonder the horses are not frightened by the fires," thought Lucy: she had been for some time breathing short, in dread every instant that the horses would start off the raised road, and overturn the carriage, or plunge and throw the man, or set off full gallop. When none of these things came to pass, and when she saw the postillion so inconceivably at his ease as to lean over, and pat his horses, and then take off his hat and tighten the band, and try it again and again on his head till it fitted, Lucy began to breathe more freely, and she observed how plainly they could see the man and horses, and the black shadow of the carriage upon the road.

Then exerting herself to find something to say, to show that she was not afraid, she looked for the burning tower, but it was concealed by a turn in the road, or it was confounded with other distant flames.

"It is like the country of the fire-worshippers in the

Arabian Tales," said she; "and there they are," pointing to a group of figures. She saw by one of the fires, nearest the road, figures with pale faces, like spectres, the light shining strongly on them. She could see the man's bare arms, and his shovel, as he shovelled up the burning mass. "And the boy standing by, and the woman with the child in her arms, quite like a picture I have seen somewhere."

"But never anywhere," said Harry, "did you see such a real sight as this—all those lone fires for miles round, burning how, or for what, I cannot imagine."

"It is like the infernal regions! is not it, Harry?" said Lucy.

"I never saw them," said Harry, "nor any thing like this! It is very wonderful. What can the fires be for? signal fires!" No, thought Harry, there are too many, and on flat ground.

"Signal fires are always on hills, are not they, father? I see these fires near us are from little heaps or hillocks of earth;" but whether they were artificial or natural, made by men's hands, or thrown up by subterranean fires, Harry could not divine. He wished to find out, he desired not to be told, and yet he almost despaired of discovering.

"Father, I have read in some book of travels, of fires that burst out of the ground of themselves. And I have heard of some lake of pitch, or some—what do you call it?"

"Bitumen, do you mean?"

"The very thing I wanted; father, are these fires of that sort, from bitumen, or do they burst out of the ground of themselves?"

"Not exactly either," said his father, "but those are both good guesses."

"The fiery tower again, brother!" cried Lucy. They came near enough to it now to see its dark form, and even to hear the roaring of the fire. The body of flame undiminished, undiminishing, kept spouting up from the top of the black tower, blown to and fro by the wind, nobody near or heeding it. When the road brought them to the other side of the tower, they saw an open red arch underneath, which seemed to be filled with a sloping bed of fire.

Harry had often seen a lime-kiln burning in the night.

"It is a lime-kiln, I do believe, only of a different shape from what I have seen."

"No," said his father; "but that is a sensible guess."

"Then it is a foundry! I have it now. I remember the picture in the Cyclopædia. It is a foundry for melting iron or brass. Now I begin to understand it all."

"And there are others of the same sort," said Lucy, "coming in view. And what is that black shadowy form moving up and down regularly, and continually, like the outline of a steam-engine?"

"Like the great beam. It is a steam-engine," cried Harry. "I see others. There they are, going on all night long, working, working, working, always doing their duty by themselves, and of themselves; how very—"

"Sublime," said Lucy.

His father told Harry that he was quite right in supposing that these were foundries. As to the fires, he said most of them were low ridges of coal, which were burning into coke for the use of the forges. The process was very simple. After the coals were set on fire, a man was employed to cover them with ashes, through which the smoke could escape, till they were sufficiently burnt. Coke, he told them, gave out a more steady and intense heat after the gas and smoke were driven off. Some of the fires, he added, might perhaps proceed from the refuse small coal, which were known occasionally to ignite spontaneously, and were suffered to burn, as there was no danger of their doing any mischief in this waste land.

When this explanation was given, Lucy's interest a little diminished with the mystery; but Harry's increased when he considered the wonderful reality.

"I should like to see this country by daylight," said Harry; "and to learn what those numbers of steam-engines are doing."

"That must be for to-morrow," said his father.

When they visited the fiery moor by daylight, they saw only a black dreary waste, with half-burning, half-smothering heaps of dross, coal, and cinders. Clouds of smoke of all colours, white, yellow, and black, from the chimneys of foundries and forges, darkening the

air; the prospect they could not see, for there was none. It was a dead flat, the atmosphere laden with the smell of coal and smoke. The grass, the hedges, the trees, all blackened. The hands and faces of every man, woman, and child they met, begrimed with soot! The very sheep blackened! not a lamb even with a lock of white wool, or a clean face. Lucy said that it was the most frightful country she had ever beheld. Harry acknowledged that there was nothing beautiful here to be seen; but it was wonderful, it was *a sort of sublime.* He could not help feeling a great respect for the place where steam-engines seemed to abound, and, in truth, to have the world almost to themselves. These laboured continually, in vast and various works, blowing the huge bellows of the furnaces of smelting-houses, forges, and foundries, raising tuns of water each minute, to drain the depths of the coal-mines. The strokes of the beams of the steam-engines were heard at regular intervals, and the sound of the blast of the furnaces at a distance. As they approached the foundries the noises grew louder and louder, till, as they entered the buildings, the roaring of the draught was tremendous. Lucy, involuntarily holding her breath, looked up to her father; she saw his lips move, but she could not hear what he said. She held fast by his hand, and stood still. She saw an immense furnace, full, as she thought, of liquid fire, but it was redhot liquid metal. One man with brawny arms, bare up to the shoulders, and a face shining with perspiration, was carrying this fiery liquid in a large ladle. Another poured it out into moulds of sand. Some men, with white caps on their heads, and pale fire-lighted visages, were hurrying to and fro, carrying, in long-handled tongs, masses of redhot metal. Others, seen in the forge at a distance, were dragging out redhot bars, while two were standing with huge hammers raised, waiting the moment to give their alternate blows. Lucy tried to make Harry understand that she thought the men were like Cyclops; but she could not make him hear the words. In this place, it seemed in vain for human creatures to attempt to make use of their voices. Here wind and fire, the hammer, the bellows, the machinery, seemed to engross the privilege of being heard. The men went on with their business in silence, only making signs when they wanted you to stand out of the way.

While they were seeing the foundry they were met by Mr. Watson, the master of the works, to whom Harry's father had a letter of introduction. He apologized for not having been able to attend them himself. But now, he said, he was at leisure for some hours. He hospitably invited them to his house, which was at a little distance. There he introduced them to his wife and sisters. Luey and her mother stayed with these ladies, while Mr. Watson took Harry and his father to see his colliery. They were one by one to be let down in a bucket into the shaft of the coal-mine, which was like a deep well. Mr. Watson, turning his eyes upon Harry, asked his father if the boy would be afraid to go down. Harry, colouring highly, answered for himself, "No, sir, I am not afraid to go wherever my father goes."

His father went down first with one of the colliers in the bucket; it was let down by the rope from a steam-engine. In a few seconds Harry lost sight of him, and soon the bucket reappeared, with only the collier in it.

"Now you may go down or not, just as you will," said Mr. Watson.

"I will go down," said Harry.

"Then do not be in a hurry. Let me put you into the bucket."

He took him by the arm and lifted him in, and the collier bid him be quite still, and he was so. The bucket was let down, and it grew darker and darker as they descended, till at last he could see only a little speck at the opening at top, like a star of light. He could but just distinguish the man's hand and arm, like a shadow, as he pushed against the sides of the shaft to keep the bucket from striking. They landed safely at the bottom, where there was lamplight, and Harry sprung out of the bucket, with the assistance of his father's hand, and he was very glad that he had had the courage to go down. As soon as Mr. Watson had descended and joined them, he took them through the galleries and passages of the coal-mines, and showed Harry where and how the men were at work. Harry was surprised to see the numbers of workmen; and of carriages that were conveying the coal. And here he had the pleasure of seeing what he had long wished for, the manner in which a steam-engine was employed in pumping out the water that collects in a mine. Before steam-

engines had been brought into general use, the master told him that it was the labour of years to do what is now, perhaps, done in a few days.

His father stopped to look at a kind of lamp which has been used for some time in lighting mines; and which, from its peculiar construction, is called the *safety-lamp*, as it completely prevents the fatal accidents that formerly occurred from the explosion of inflammable vapours, when ignited by the unprotected flame of a candle. Harry wished to understand it, but his father told him he would explain it to him at another opportunity; that they must not delay now, for Mr. Watson's time was precious, which Mr. Watson did not deny. However, he did not hurry them, he only spoke shortly, passed on quickly, and called to the man at the windlass to "Let down." They were drawn up in the same manner by which they had descended, and Harry was glad to see the daylight again, though it dazzled him, and to feel the fresh air. Next they saw the iron railroads, on which small carts, loaded with coal, were easily pushed along by one man, sometimes by one child guiding or following them; and presently they came to what Mr. Watson called "the inclined plane." Harry saw two roads of railway, placed beside each other up and down a steep slope. On one of them there were several empty coal-carts linked together; and on the other a cart loaded with coal, which, as it ran down the slope, dragged the empty carts up. This was effected by means of a chain, which was fastened by one end to the loaded cart, and by the other to the empty carts, and which passed round a large pulley at the top of the slope or inclined plane; so that the loaded cart, descending by its own weight on one road, made those on the other road ascend.

"Little man, you may take a ride up and down if you will," said Mr. Watson; "safe enough, and I see you are no flincher, and not bred too daintily to sit in a coal-cart, a slave to a coat or a jacket."

Harry jumped upon one of the empty carts.

"Throw him a truss of that hay to sit on. There, hold fast now for your life. Keep an eye on him. Up with you."

And up he went, and from the top looked down upon his father, and for a moment he felt afraid to go back again, it looked so steep. A collier's boy, who was

standing by grinning, told him he went "up and down the same way ever so many times a day, and no harm never." Harry said to himself, "If it does not hurt others, why should it hurt me?" And thus, conquering his fear by his reason, he took his seat, and down he went.

"Father," cried Harry, as soon as he had one leg out of the cart, "I am glad Lucy was not with us. She would have been frightened out of her wits at seeing me coming down."

"Look to yourself now, and take your other leg out of the cart," said Mr. Watson, "for we want the cart to go up again."

"It was lucky I drew my leg out of the way in time, or I should have been thrown out of the cart along with that mountain of coal," said Harry.

"Yes, people must take care of their own legs and arms in these places," said Mr. Watson; "and in all places it is no bad thing to do.'

Bluff and rough as he was, Harry liked Mr. Watson, who was very good-natured, and whenever he had time to think of the boy, pointed out what was worth his seeing; but once nearly threw him into a ditch, by swinging him too far with one arm over a stile. At the next stile Harry said,

"I would rather get over by myself, sir, if you please."

"Do so, if you can; and I see that you can, so I need not trouble myself more about you."

It was dinner-time when they reached Mr. Watson's house. Here they dined at an earlier hour than Harry and Lucy were used to, but they were quite ready to eat; Harry especially, after all the exercise he had taken. The dinner was plentiful, though plain, and there were creams and sweet things in abundance, for the master loved them, and his wife and sisters were skilled in confectionary arts. As soon as the cloth was removed, Mr. Watson swallowed a glass of wine, and pushing the bottle to his guests, rose from table, saying, "I must leave you now to take care of yourselves, I must go to my business."

Harry jumped up directly and followed him to the door. His mother called him back, saying, she was afraid he would be troublesome. "Mr. Watson did not ask you to go with him, did he?"

"I did not think of the boy," said Mr. Watson, looking back from the door. "I am going only to see my workmen paid this Saturday evening; this would be no diversion to you, my boy, would it?"

"Yes, it would," said Harry, "if I should not be troublesome," he was going to say, but Mr. Watson went on,

"Follow, then, and welcome. You will not be any trouble to me: I shall not think of you more than if you were not with me."

So much the better, thought Harry, who liked to stand by, and see and hear without anybody's minding him. Mr. Watson, hastily swinging round his great-coat as he spoke, flung the flaps into Harry's eyes; but Harry, not minding that, ran after him; Mr. Watson strode across the courtyard, and up the office stairs, three steps at a time. The room was full of men, who made way directly for their master, but the crowd closed again before Harry could pass. However, he squeezed in under the elbows of the great men, till he got to a corner beside the desk of the clerk, who was sitting with a great open book, and a bag of money before him. Harry knew he was not to interrupt, so he asked no questions, but got up on a tall, mushroom-topped leather stool, which stood beside the clerk's seat, and watched all that went on. He was amused with the countenances of the men, who each in turn came to the desk. He observed that Mr. Watson was, in the first place, very exact to see that they were rightly paid. Once, when there was some difficulty with a deaf, stupid old man, about the *balance* of his account, he looked into the books himself, to see whether the old man or the clerk was right; and Harry, looking and listening, tried to learn what was meant by this *balance of account*. Mr. Watson was better than his word, for he found time between the going away of one class of workmen and the coming of another, to explain it to Harry, whom he saw poring over the clerk's shoulder, and who once ventured to say, "Where is the *balance* that he is talking of?"

"Look here, the whole mystery is this. Look at the top of these pages, and of all the pages in the book. Dr. and Cr., that is, *Debtor* and *Creditor*. Debtor on the left-hand page; Creditor on the right-hand page. All that this man owes to *me* is put on the debtor, or left-

hand side of the book; all that is due to *him* is to be put on the creditor, or right-hand side. Then add together all the sums that belong to the debtor side, and all the sums that belong to the creditor side, and see which is the *heaviest* or largest, and deduct the least or *lightest* sum from it; the difference, whatever it may be, is called the *balance*. You may consider an account as a pair of scales, and the sums put on either side as weights: the sides are at last to be made to balance each other, as the weights in the opposite scales. Now, for example, look here, at John Smith's account; debtor side two pounds; creditor side four pounds eight shillings; you, my boy, may make out what the balance is which I am to pay him. Write your answer down when you know it. But take your head out of my way. I must go on with my business."

Harry wrote his answer with a pencil, and put it on the desk before Mr. Watson; but it was long before it was seen or thought of.

"Two pounds eight shillings is the balance due to John Smith."

"Right," said Mr. Watson. "The same method is observed in keeping all accounts; the money paid by the person who keeps the account is put on the debtor side, and the money received by him on the creditor side."

"Is that all?" said Harry.

"All in simple accounts," said Mr. Watson. "But *book-keeping*, though on the same principle, is much more complicated."

Harry was interested in listening to what was said to the people: Mr. Watson inquired how they were going on at home, and they told him all about their wants, and their hopes, and their fears.

Several of the workmen left part of the money in his hands, to be put into the *Savings' Bank*. Harry understood that by so doing the men obtained a provision for the time when they might be sick, or must grow old. There was one slovenly man in rags, ill-patched: when he came up to be paid, Mr. Watson looked displeased, and said, "What a shame, Giles, to see you in such rags, when you earn so much? If you would put less of your money into your cup, you would have more on your back."

Harry understood what he meant. The ragged man

walked away ashamed, while his companions laughed at him. Mr. Watson was steady as well as good-natured to the people. The industrious and frugal he encouraged, the idle and drunken he reproved, and he took pains to see that justice was done to them all.

While Harry had been seeing these workmen paid, and learning what is meant by the balance of an account, Lucy had been learning something equally interesting to her, concerning sugarplums and sugarcandy: one of Mr. Watson's sisters was well informed both in the practice and theory of confectionary. As soon as Harry came in, Lucy ran to him, to tell him what she was intent upon; and he was obliged, for the present, to keep his debtor and creditor accounts to himself.

"Harry, my dear! you know those little, tiny sugarplums, which are no larger than the head of a minikin pin?"

"I think I know the sugarplums you mean," said Harry; "but I do not know a minikin pin, nor the size of its head."

"Then never mind," said Lucy; "I forget that you, being a man, could not know minikin pins as well as I do. But as to the sugarplums, you saw some this very day at dinner on the top of the trifle."

"I remember," said Harry. "Well."

"Well, my dear Harry, you can have no idea what hard work it is to make these little comfits. Miss Watson was telling me how she made ginger-sugar; and afterward I asked her if she could tell me, or show me, how those little sugarplums are made. She said that she could not show me, for that she could not make them herself, not being able to bear the heat in which they must be made. She told me that the pan in which they are boiled must be set over a great fire, and that the sugar of which they are made must be stirred continually in that heat. A man with a long-handled shovel keeps stirring, stirring, stirring; and sometimes strong men faint in doing this."

Harry wondered that some way of stirring the sugar in these pans by machinery had not been contrived, and he was going to question Lucy farther upon the subject, but she was in a great hurry to go on to sugarcandy.

"Harry, do you know how sugarcandy is made? I will tell you, for I have just learned. When sugar is dissolved, it is poured into pots, across which sometimes thin rods, and sometimes threads, at a little distance from each other, are stretched. These moulds, and the liquid sugar in them, must all be covered up, and kept in a great heat for a certain time, and nobody must disturb them. They are placed in a room, which is one great stove; care is taken that no wind should be admitted, for they say that the least disturbance spoils the whole, and prevents the sugar from forming into those regular-shaped crystals which you have seen in sugarcandy. If the vessels are not disturbed, they form on the little rods I mentioned to you, or on the strings. I dare say you remember often finding strings in sugarcandy; and now we understand the use of them."

"But what do you mean by crystals?" said Harry. "Will you explain?"

"I remember I once thought," said Lucy, "that crystals meant only bits of that white substance which looks like glass. But Miss Watson has explained to me that there are crystals of various sorts and substances, of sugar for instance, and sugarcandy, and of I do not know how many kinds of salts; in short, of all substances that can be crystallized: those were her words, as well as I can remember."

"Very likely," said Harry; "but still I do not know exactly what is meant by what you call crystallizing."

"Turning into crystals," said Lucy. "What more would you have? Here is what they call a crystal of sugarcandy. Here are its regular sides: crystals, you know, have always regular sides, and a regular number of them. Look at it, and touch it, and taste it if you will."

Harry looked, and touched, and tasted; but still, not quite satisfied, he said, "I want to know what difference there is in things before and after what you call crystallization."

"The difference in this *thing* is very plain," said Lucy. "Before it was crystallized it was sirup, that is, sugar and water: and now you see it has become solid."

"Very well, so far I understand," said Harry, "but how or why do fluids crystallize?"

Lucy did not know, she confessed, and was well

satisfied to let the matter rest there for the present. Some time afterward, she took notice of an ornament on the chimney-piece; a small basket, which looked as if it were composed of crystals of glass, or of white spar.

Miss Watson told her that it was not made either of glass or spar. "I made it," said she.

"You made it! How could you make it," said Lucy. "And of what is it made? It looks something like white sugarcandy; perhaps it is made in the same way; perhaps it is a sort of sugarcandy."

"The taste would soon decide that," said Harry. "May I just try the experiment with the tip of my tongue."

Miss Watson gave him leave to taste it, but she warned him that he might perhaps not like the taste.

"Then I guess what it is," said Harry. After having applied the tip of his tongue to one of the crystals, he added, "By the taste, I am sure it is alum."

It was alum. Lucy had seen large pieces of alum; but none large enough to be hollowed out into a basket of such a size, and it would have been difficult to have carved it into such regular shapes. She recurred to her first idea of the resemblance to sugarcandy, and she continued to think that it was made by the same means. Miss Watson told her that she was so far right in her guess, that it was made in the same manner as sugarcandy, that is, by crystallization. She showed her the whole process, which is very simple. In the first place, she put some water into an earthen pipkin, with as much alum as could be dissolved in that quantity of water. She boiled it till the alum was dissolved. By these means, she told Lucy that she had obtained a *saturated solution* of alum, that is, that as much of the alum had been dissolved as the water could hold. Then Miss Watson took a little wicker basket, and suspended it by its handle on a stick laid across the mouth of the pipkin; so that the basket, handle and all, were totally immersed in the dissolved alum. The basket did not touch the bottom of the pipkin. As it was very light, it would not have sunk in the water, had not a little weight been put into it. The whole was then covered with a coarse cotton cloth, and put aside in a cool place, where it was not likely to be disturbed. She advised Lucy to let it alone during a day and night, to give time

for the crystallization to go on slowly, so as to form perfect crystals, which can be obtained only by the slow and regular evaporation of the water.

There still seemed to be some difficulty in Lucy's mind after she had heard this, and looking at Harry, she said,

"I know what you are thinking of, Harry, and I am thinking of the same thing; that I wish I knew exactly what is meant by *crystallization*."

"That was what I was thinking of," said Harry, "and I was wishing that I could get at a book which we have at home, in which I know that there is an explanation of it."

Miss Watson asked if the book was Conversations on Chymistry.

"The very book! how quickly you guessed it. And you have it! how very lucky!" said Lucy, as Miss Watson took the book from her bookcase. She found for Harry the passage that he wanted. It begins with Emily's saying,

"*I do not quite understand the meaning of the word crystallization.*"*

"That is exactly what I felt," said Harry.

"And what I ought to have felt," said Lucy. "But I really did not know that I did not understand it till you asked me to explain it, Harry. Now let us read on."

After reading a few lines she came to the word *caloric*, and asked if caloric meant the same as heat.

"Not exactly," Miss Watson said; "in this book the difference is defined."

She turned to another part of the book, and showed Lucy the passage which defines the difference between heat and caloric.† The subject was new to Lucy, and almost at every line she wanted explanations. She stopped, and whispered to Harry that she was not sure she knew what was meant by "*the integral parts of a body*." Miss Watson turned to the beginning of the volume, and showed her a perfectly clear explanation of *integral parts*.‡

"How well you know all this!" said Lucy. "You know where to find every thing in this book."

Miss Watson said that was not surprising, for that she had read it more than once.

* Conversations on Chymistry, vol. i, p. 341; eighth edition.
† Ibid., p. 35. ‡ Ibid., p. 9.

"The first time you read it did you find it difficult?" said Lucy.

No, she said, she had not found it difficult, but very easy and clear.

"Ah! because you did not read it till you were grown up, I suppose?" said Lucy.

Miss Watson said that she did not think this was the reason, as she had seen readers not older than Lucy understand it perfectly well.

"It is very odd, then," said Lucy, "that I am obliged to stop, you see, two or three times, before I have read a single page, to ask the meaning of the words."

"Because you have begun in the middle; you have not read the book from the beginning," said Miss Watson; "or else you would have found all the terms explained as you went on."

"But even so, I am afraid I should have forgotten them," said Lucy, sighing. "You must have a very good memory to remember them all."

Miss Watson said that, besides having read the book from the beginning, she had often looked back to the definitions of the words, and to the explanations, whenever she found herself not clear as to what was meant.

The conversation afterward turned upon different subjects, in which Lucy had no concern; therefore she followed Harry, who took the Conversations on Chymistry to a comfortable nook in the room, where he could be quiet, and, after his slow but sure manner, he made himself understand thoroughly what he was reading. Lucy read more quickly, and when her mother and Miss Watson were passing by them, she caught hold of the skirt of her mother's gown, and said,

"I understand this passage about crystallization now, mamma, I think; it is very clear."

"I do not in the least doubt that *it* is very clear, my dear," said her mother, "but are *you* very clear?"

"Here, mamma, if you will just look at the book, at this passage, mamma, which begins, 'Crystallization is simply—'"

"I do not want to read it, my dear," said her mother, "or to hear you read it, but tell me the sense of it in your own words."

"But, mamma, though I do understand it," said Lucy, "you know it is impossible that I could put it in such good words."

"I am well aware of that, Lucy," said her mother; "but explain it any words that will express what you mean; then you will be certain of what you know or do not know."

"Well, mamma, in the first place, suppose a body, that is, a substance—"

"What kind of a body? what kind of a substance?" said her mother.

"It must be a fluid," said Lucy. "Yes, mamma, before it can be crystallized, it must be a fluid. Therefore begin by supposing a fluid. No, I believe, that first of all, before it becomes fluid, the body should be a solid. Hey, Harry! Which shall I tell mamma to suppose, a fluid or a solid?"

"Settle it for yourself, Lucy, my dear," said her mother. "It cannot depend upon what Harry thinks, but upon what really is the fact."

"I recollect it all now, mamma," said Lucy, after a short pause, "and I will begin again with a solid body, mamma; suppose a solid body, sugar, for instance, or alum, mamma, is dissolved, either by heat or by water; and suppose that none of its *original* parts, that is, the parts of which it was originally composed, are lost by being dissolved, but only separated, as it were, by the water, or by the heat by which they are dissolved. Then, mamma, if you could again take away the heat or the water, the original parts of the substance, the alum, for instance, would come together again, and adhere, when what separated them is gone. This is crystallization. You may take away the heat by cooling it, and then the first parts come together again in a solid form. Or you may evaporate the water, which separated the parts, by heat; and then they will come together again, crystallized. Whatever way you do it, whether by heat or cold, if it is not disturbed, but allowed to go into its regular forms, it is called crystallization."

"You have laboured through your explanation, Lucy, tolerably well," said her mother.

"But there is one other thing more you should say, Lucy," said Harry.

"Say it for me," said Lucy.

"That different substances form into crystals of different shapes. Crystals of substances of different sorts, as I have just been learning," continued Harry, "have always a certain regular number of sides; as

that when you see the crystal, after counting the sides, you can tell of what it is composed; or you can tell beforehand the number of sides and the shape of the crystals that will be formed from any known salt or substance which you have dissolved, and left to crystallize."

"For instance, alum," cried Lucy. "The alum which was dissolved in the hot water, and which Miss Watson has left there to crystallize, we know, will be in the same shaped crystals as these in this first basket. I will count, and tell you the number of sides."

Harry said he thought that Miss Watson could, if she pleased, tell the number of sides without counting them, and so she did.

"How difficult it must be," said Lucy, "to get by heart, and to keep in the memory, the number of sides which belong to all the different kinds of crystals!"

"You need not do that," said Miss Watson. "Lists of them are to be found in many books, to which you can refer when you want them."

"But you know alum without looking at any book," said Lucy.

"Yes, because I had been accustomed to see its crystals," said Miss Watson. "As I told you before, many of the facts in chymistry or mineralogy, which it would be difficult to remember separately, or merely for having read or heard an account of them, are easily fixed in the mind by trying experiments, and by connecting those facts with others."

Miss Watson told Lucy that she had become particularly fond of this study, because her father was a chymist, and she had often been in his laboratory while he was at work. "Unless I had seen the actual things I should not have remembered the descriptions of them, I am sure," said she; "besides, I was so much interested in my father's experiments, and so curious to know whether they would turn out as he had previously expected, that the whole was fixed in my memory. Unless I had had somebody with whose pursuits I could sympathize, and in whose discoveries I felt an interest, I should soon have forgotten even the little I had learned."

"But does not it make you happy?" Lucy asked.

"Are you or are you not happier than if you had not this pursuit?" said Harry.

Miss Watson smiled at the earnestness with which they questioned her; and answered, that she thought she was much happier for having this taste and this occupation. She said it never prevented her from doing other things which were more necessary. To this her brother added his testimony.

"Her being something of a chymist has not spoiled her hand for being a good confectioner," said he. "On the contrary, it has improved it, for she knows the reasons for what she is doing. All confectioners and cooks must be chymists for so much, but they do not know the reasons why they succeed one time, and fail another. With them it is all knack, and hap-hazard, or what we call *practice*, at best. Now," continued Mr. Watson, "here is an old receipt-book, which belonged to the great-grandmother of a noble family, famous in her day, no doubt, for her cakes, and puddings, and confectionaries, and cures for all manner of sprains, and aches, and bruises: look at any of these, and you will see what nonsense half of them are. How many useless ingredients are put into the receipt, either on purpose to puzzle other people, or from ignorance, and a sort of superstitious belief that there was a *mystery* in doing these things."

Harry and Lucy amused themselves by looking at some of these old receipts, which, however, were hard to decipher, the ink being yellow, and the spelling old and incorrect.

The next day was Sunday. Harry and Lucy went with their father and mother, and Mr. Watson and his family, to church. The church was in the village near the house. As they were walking home, Mr. Watson asked if they would like to see some of the houses in the village where his workmen lived, and the cottages in the neighbourhood. Harry and Lucy were glad to take this walk, and Harry kept close to Mr. Watson wherever he went.

In one cottage, the master of the house, a great fat man, was sitting at his dinner. Hot-roasted duck and cauliflowers were on the table before him; while his wife, a pale, starved-loking soul, was standing behind his chair, waiting upon him, and his children were huddled together in a corner, at a distance. He never let any of them eat with him. He laid down his knife and fork as the company came in, trying, as much as he

could, to soften his sulky look. Mr. Watson spoke kindly to his wife and children, but took no notice of the man. As he went out of the house he said, loud enough for him to hear,

"I should have no appetite for my roast duck if I were forced to eat it by myself, without my good wife to take a share."

Lucy wondered that Mr. Watson did not insist upon the husband's letting the wife and the poor children sit down with him.

But Mr. Watson replied "that he had no right to do this; every man had liberty to do as he pleased in his own house and in his own affairs. He could not interfere between man and wife farther than he had done, by laughing at the surly husband, and shaming him before company." He said he had known this man buy, for his own eating, the first green peas of the season, when they were expensive rarities; even when his children had not clothes to cover them.

"The selfish creature!" said *Lucy*.

"The brute!" said Harry.

In the evening, as they were walking in a pretty lane near Mr. Watson's house, they met a man who was endeavouring to come up the lane; but he could not, by any efforts he could make, walk in a straight line; he was so much intoxicated that he scarcely knew what he was doing. When he met Mr. Watson he started, stammered, tried to take off his hat, and to stand out of the way, but he could not accomplish it. Lucy was very much shocked. Mr. Watson called at his clerk's house, and ordered that this man, John Giles, should be struck off the list of workmen, and should not be admitted to the foundry for the next week; and that Markham, who was a sober fellow, should come in his place.

Harry thought this was very right till some time afterward, when the drunken man's wife came to Mr. Watson, to beg him to pardon her husband, and to readmit him to the work. She said that if he did not she and her children must suffer for it; that her husband would beat her, and only drink the more if he was vexed. The tears rolled down her face as she finished speaking. Harry wondered how Mr. Watson could refuse her, for it was not her fault that her husband was drunken.

At night, when Harry was in his father's room, he

talked to him about this, and asked him whether he thought Mr. Watson was right or wrong. Right, his father said; he did not think his refusal was hard-hearted, but steady; because it was his duty to do what was just for a great number of people, as well as for this one man. If he were to employ a drunken workman in preference to a sober man, this would encourage the drunken, and be unjust to the sober.

"I would not encourage the drunken and idle upon any account," said Harry. "I thought Mr. Watson was quite right at first, in ordering that he should not be admitted to the works for a week. But might not Mr. Watson have forgiven him for the sake of the woman?"

"Then any other workman might drink, and might hope that his wife would beg him off, and obtain his pardon," said Harry's father.

"Father," said Harry, after a long silence, and looking very serious, "I thought that a great mechanic was only a person who invented machines, and kept them going, to earn money, and to make things cheaply. But now I perceive that there is a great deal more to be done; and if ever I grow up to be a man, and have to manage any great works, I hope I shall be as good to my workmen as Mr. Watson is. I will be as just and steady too, if I can. But, father, I see it is not so very easy to be just as I should have thought it was. There is a great deal to be considered, as I find from all you say about forgiving or not forgiving the drunken man for his wife's sake. I feel that I have much more than I know of before to learn."

"Harry, I wish you would go to bed and to sleep," said his mother; "for I am sure you must be tired after all you have seen, and heard, and thought, this day."

"Not in the least, mother. I never was wider awake," said Harry. "However, I will go to bed to please you."

Our travellers were to set out before breakfast, and very early in the morning. The family promised that they would not get up to see them off, lest they should delay them on their journey. Lucy did not forget to inquire for the alum basket when she wished Miss Watson good night and good-by.

"If it has succeeded you will see it in the hall as you pass through in the morning," said Miss Watson; "but yesterday one of the servants shook the vessel contain-

ing it, and by that means prevented the crystals from forming rightly. I was forced to begin the whole operation again. This time I locked the door to secure its being undisturbed."

As soon as she was dressed in the morning, Lucy ran down to the hall to see whether the basket was there. And there it was, standing beside her bonnet. The wicker skeleton was no longer visible; every part of it, handle and all, being covered with crystals of alum, apparently perfectly formed. She did not, however, stay to examine exactly, or to count their sides, which is always a tedious business; but seeing a note directed to herself tied to the handle, she tore it open immediately. It told her that this basket was hers if she liked it.

"*If!* to be sure I do!" said she.

Miss Watson suggested that if Lucy should ever attempt to make such a one, she might put into the solution of alum a little gamboge, which would give to the crystals a pretty yellow teint; or she might mix with it any other colour she preferred.

Within the basket, nicely placed, Lucy found several little paper cornucopiæ, filled with sugarplums, and rose, and lemon, and barberry drops, with receipts for making each, written within the papers in which they were contained.

She was so much delighted with her cornucopiæ, and their sweet contents, and with the pretty crystallized alum basket, and with the good-natured maker and giver of these good things, that she could think of nothing else during the first hour of the morning's journey.

"Now, mamma, will you taste the barberry drops? Excellent, are not they? and the lemon, better still! Oh, mamma, cannot you taste any more? here are seven other kinds."

Before breakfast it was impossible to taste all the seven, even to oblige Lucy, and in honour of Miss Watson. But Harry was an indefatigable taster. He went on without resistance, but without giving what Lucy deemed sufficient tribute of praise to each. At last, when much urged by the repetition of "Is not it excellent, Harry?" he confessed that the tastes of different drops were now all so mixed in his mouth that he could not tell one from the other. Lucy shut up her cornucopiæ, and reserved her plenty for time of need. "But, mamma," said she, "when all these are gone,

now that I have the receipts, I can make the same whenever I please."

"It is not quite certain," her mother said, "that because you have the receipts you can make others equally good, whenever you please."

Piqued a little by this observation, and by a smile of Harry's, Lucy began to form various schemes of trying experiments, in making rose and barberry drops, and sweetmeats, like those which she had tasted of Miss Watson's, and which everybody had liked. She enumerated such numbers of things which she intended to make, that Harry at last laughed, and said,

"My dear, you will then turn cook and confectioner quite, and forget every thing else."

Her mother observed that it was useful to know how those things should be done; but that the propriety of making or not making them ourselves depends upon the circumstances in which we are placed, and on our rank of life. Those who have servants that can make them, would act foolishly in wasting on such work their own time, which they may employ more advantageously. Miss Watson, who perhaps had no servants that could make these things, did wisely and kindly in making them herself for her friends who like them; and it was particularly obliging and amiable of her to condescend to do so, because she has other pursuits, and a cultivated understanding. Lucy's mother told her, that if she persevered in her wish to learn how these things were made, she should, at the proper season of the year, see and assist the housekeeper in making sweetmeats. This satisfied her. And she was at leisure to listen to Harry, who, for his part, was anxious to become a chymist, and who had been struck with the idea of the happiness of the person who possessed a laboratory, and could try chymical experiments. His father told him that it was not necessary to have a laboratory and a great apparatus for this purpose, as one of the most ingenious and successful of chymists and philosophers has observed. Many most useful and excellent experiments can be tried in an easy and simple manner.

Here his father was interrupted by an exclamation from Lucy, at the sight of a tall finger-post, on one of the arms of which she observed, To BIRMINGHAM.

Harry and Lucy anxiously watched to see whether the driver turned down this road, as they had both an ar-

dent desire to go to Birmingham to see some of the manufactures, of which they had heard most interesting accounts. Lucy's astonishment had been excited by some scissors which Mr. Frankland had shown her, which she had tried, and which, though not of the most beautiful polish, cut sufficiently well for all common purposes, and yet, oh, wonderful! Mr. Frankland told her, that this pair was one of a dozen which he had bought for one shilling!

Harry's curiosity had been raised by hearing of a knife with five hundred blades, which he had been told was to be seen at Birmingham.

The knife came first to his recollection; an instant afterward, however, he said, "But there are things there a thousand times better worth seeing than that."

"Oh father!" cried he, turning to his father, "I hope we shall go to Birmingham, that we may see all the grand works at Soho, Mr. Boulton's. I read an account of them while we were at Mr. Frankland's, in one of the notes to the Botanic Garden, when you were looking for the Barberini vase, Lucy. It said that there is a magnificent apparatus for coining, all worked by one steam-engine, which cuts halfpence out of sheets of copper, and at one stroke stamps both the faces and edge of the money."

"Yes, I remember your reading it to me," said Lucy; "and it was said that four boys of ten or twelve years old, no bigger, mamma, than Harry, could, by the help of this machinery, worked by that great giant enchanter, the steam-engine, make—how many guineas do you think in one hour? thirty thousand, mamma. Was not it, Harry?"

"Yes, thirty thousand," repeated Harry; "and besides this, it is said that the machine keeps an exact account."

"An *unerring* account was the very word," said Lucy. "It keeps an unerring account of all the money it coins. Papa, I do hope you are going to Birmingham. Oh! mamma, I hope we shall see all that was described in those lines, do you recollect? I hope we may see,

> "'Hard dies of steel the cupreous circles cramp,
> And with quick fall the massy hammers stamp.'"

Her father told her that he believed that these massy hammers are no longer at work at Soho; but that a far

more magnificent apparatus for coining is now established at the Mint in London. He hoped, he said, to show them all these wonders of mechanism, of which they had read in prose and poetry, at some future time. For the present, however, he must disappoint them. He could not go to Birmingham, he must pursue the road to Bristol. Even on their account, he added, addressing himself to their mother, he did not now choose to go to Birmingham. The general principles of a few great inventions, he hoped, had been clearly understood and fixed in their minds by what they had already seen. He was glad to find that they had taken pleasure in following the history of the progress and consequences of those noble discoveries; he would therefore take care not to confuse their minds, by showing them the details of small ingenious contrivances in the Birmingham workshops and manufactories, or by dazzling their eyes with the sight of more than Arabian Tale magnificence, in the show-rooms of "The great toyshop of Europe."

Harry and Lucy had not been so much spoiled by their father's and mother's indulgence that they could not bear disappointment. One sigh Lucy was heard to give for the *great toyshop of Europe*. Harry suppressed his rising sigh; for, since the steam-engine coiner was not to be seen, he cared little for the rest. They both agreed "that papa knew best."

And this was not with them a mere phrase, said with a look of hypocrisy, but with honest faces and hearts, and firm belief, from experience, of the truth of what they said.

"What is the name of the town to which we are coming next, mamma?" said Lucy.

"Bridgenorth, my dear."

"Bridgenorth!" repeated Lucy; "I am sure there is something I have heard about Bridgenorth, but I cannot remember what it is."

"I know what it is, I believe," said Harry, "a famous leaning tower."

"Yes," said Lucy, "that is the very thing! I recollect reading about it in my History of England, which said that this tower of Bridgenorth was not always leaning: formerly, a great while ago, it was upright and

like any other tower, but it was shaken from the foundation when it was bombarded, during some siege in the time of the civil wars, was not it, mamma? I read it to you: and it has hung over in the same leaning state ever since, looking as if it would fall, and yet not falling. I am glad we are to pass through Bridgenorth, that we may see it with our own eyes."

"Yes, I shall like very much to see it," said Harry.

Their father desired the postillion to drive slowly when he came into the town, and Harry and Lucy's heads were first out of one window, and then out of the other, eager for the first sight of the hanging tower.

"There it is!" cried Harry.

"Of red brick!" said Lucy. "I see it. I had fancied that it was of gray old stone. I expected to see a fine, venerable, ivy-mantled tower."

"I cannot help it," said Harry; "but, my dear, take your head out of my way, for I cannot see what I want to see."

"There, you may have it all to yourself, my dear Harry," said Lucy. "I think it is very ugly."

"Nobody ever said it was pretty, did they?" said Harry; "but it is a curious thing."

"Not nearly so curious as I expected," said Lucy. "Not nearly so dangerous-looking as I fancied it must be. I had hoped that it would quite take away my breath to look at it, and that we could not drive by without fearing that it would fall upon our heads."

Harry had no such fears or hopes, because he recollected distinctly having read an account of it. He knew that at Pisa there is a tower which overhangs fourteen feet, much more than this of Bridgenorth. His father asked him, if he could tell why these sloping towers continue to stand. "What prevents them from falling, Harry, do you know?"

Harry said he believed he knew, because he had read, in Scientific Dialogues, an account of them, and an explanation of the principle on which they stand.

"I know you did," said his father, "and you understood it at the time you read it: but let me see if you understand it now."

"Father, it is very difficult to express it in words, as Lucy says; but if I had my little bricks, I could easily show the thing to you."

"Yes," said Lucy. "Very often we built towers

which leaned over, and yet stood; and we used to try how much we could venture to make them overhang without their falling: I recollect that perfectly, though I do not know the reason why they did not fall."

"If I had the little bricks, I could show and explain it," said Harry.

"But as you have them not, and as you cannot always carry a *load* of little bricks about with you, Harry," said his father, "try what you can do to explain yourself by words; those you may always have at command."

"*May*—I wish I had," said Harry.

"Begin, Harry, by thinking of what you wish to express, till you are quite clear that you know what you mean, and depend upon it you will then easily find words," said his father. "People often imagine that their difficulty is in finding words, when the real difficulty is in having clear ideas of things."

"Then you must, if you please, father, give me time," said Harry.

"As much time as you please," said his father; "and that I may not hurry you, I will go on reading this book."

"Thank you, father," said Lucy for Harry.

Harry looked back at the hanging tower, which was yet in view, and after he had thought till he was clear of what he meant to say, without considering about the words, which came when he began to speak, he went on fluently, after the first word, "father," had made his father look up and lay aside his book.

"Suppose that a plumb-line was let down from the centre of gravity of the whole mass of that leaning tower, the bob of the plumb-line would fall within the base, or foundations: the plumb-line could not hang outside of the base, or else the tower must tumble down. As long as the centre of gravity is supported any part may lean over, or may hang out of the perpendicular line, and yet, provided the materials stick together, the tower will not fall."

"I think I understand that," said Lucy, "but I am not quite clear."

"If you do not understand what is meant by the *centre of gravity*," said her father, "you cannot be quite clear, indeed, you cannot comprehend it all."

Lucy said she remembered seeing Harry, when he was a little boy, standing upon her father's knees, and

leaning his body so much to one side, that she was afraid he must have fallen. "And, papa, you then explained to me how far he might have leaned over without any risk of tumbling down. You also told me something about the centre of gravity, but that I do not recollect exactly."

"Remember how often," said Harry, "my father has shown us that the motions of our *tumbler toy* depended on the situation of the centre of gravity. By-the-by, there is a way of finding out where the centre of gravity is in a body or figure of any shape."

"Is there?" said Lucy. "I do not remember papa's showing us that. How did you learn it? And if it is not very difficult, can you teach it to me? Who taught it to you?"

"A book," said Harry; "my own good 'Scientific Dialogues.' And if I had but a bit of card, and a bit of thread, and a pin, and a pencil, and if we were not in the carriage, I think I could show it to you now."

But, as all these *ifs* stood in the way, the matter was put off for the present, and, like many good things that are put off, was forgotten. Nor can we much wonder that this was driven from the recollection even of the philosophic Harry, by the bustle he saw in the next town through which they passed. It happened that there was a great fair in this town, and it was filled with such crowds of people, and so many stalls and booths, covered with canvass, lined the streets, that it at first seemed impossible that way for their carriage and horses could be made through them, without trampling on some of the people, or overturning some of the tents. The postillion stopped, and called civilly to the people to make way: cloaks and great-coats yielded on each side, and those in front got from under the horses' noses, as they advanced step by step. Lucy had let down the glasses, and was looking out with great interest, not unmixed with apprehension, and listening to the—

> "Universal hubbub wild,
> Of stunning sounds and voices all confused."

And as, little by little, the carriage made its way through the dense multitude, she saw many hair-breadth escapes, which made her shrink, and cry "Oh!" and "Ah!" many a time, for those who were all unheedful of their danger, in the ardour of bargaining, the pleasure

of gossiping, the vehemence of scolding, the stupidity of staring, or the anxiety of maternal affection. Here was seen a mother crossing before the very pole of the carriage, which nearly ran into her ear, in so much haste was she to snatch out of the way two children, standing unconscious, the one with an apple, the other with a whistle in his mouth. And close to the wheel of the carriage, at one time, there was a young damsel, with pink cheeks, bargaining so earnestly for a pink riband, with an old woman in her booth, that the wheel must, as Lucy thought, have gone over her outstretched foot, but that just in time looking up, she drew it in, and still holding the dear riband in her hand, continued her bargaining. Next there was a group of old women, leaning on their sticks, with their bonnets close to each other, telling and listening to something so eagerly, that they never heard the carriage coming till the wheel went over the point of one of their sticks, and begrimed the scarlet cloak of the speaker before she would move her shoulder out of the way.

Then came an awkward clown on horseback, with elbows out, lugging at the hard mouth of his shag-maned colt, that knew no more than his rider the way he should go, but which, with glassy eyes starting out of his frightened head, seemed to have a mighty mind to run straight in at the carriage window. Seeing which, Lucy ducked directly. How they passed she knew not; but when she looked up again they were gone, and Harry's body was far out of the window, watching the operations of man and horse. There was the colt floundering and struggling with his rider, at the corner of the street, where both vanished before it was settled which would be victorious.

But now Lucy saw before them, in a new street, a huge wooden house or caravan on wheels, on the outside of which, in large letters, were written the names of the wild beasts that lodged within, and which were all to be seen for the sum of one shilling. Across this part of the street hung flapping, furious portraits, coloured to the life, of a lion rampant, an hyena, a tiger, and a mountain cat with enormous whiskers.

Lucy began to be a little afraid that the *poor* horses would be very much frightened. But either they did not think the portraits striking likenesses, or they were not sufficiently acquainted with the originals and their

private histories, to be as much afraid as Lucy thought they ought to be. They went by quietly, yet were, as Lucy observed, most foolishly frightened soon afterward, by a poor little boy popping out from under the long skirts of a puppet-show. One reared, the other *shyed*, but their driver being a temperate whip, patted them into good-humour, and brought them on safely to the inn. Turning under the archway, they knew where they were, lowered their pricked-up ears, and stood perfectly still at the bar door, neighing by turns to their acquaintance in the yard, who answered from their inmost stalls.

Lucy found, on the chimney-piece of the room where they were to dine, an advertisement, informing the public that—

"There is now in this town a new fairy, infinitely surpassing the old Corsican fairy, who appeared in England in the last century, and who was honoured with the approbation of the nobility and gentry. But the new fairy is full an inch less than the old fairy, and can speak three languages, French, English, and Italian, dances to admiration, and waltzes inimitably, if required."

While Lucy was reading this card, Harry was perusing another, which he had found on the table, and which informed the public that this evening, at six o'clock, a company of tumblers would, at the theatre in this town, exhibit, for the amusement of the public, several curious feats in tumbling and rope-dancing. One man promised to carry a ladder poised on his chin; and another to balance a table on the rope, and even a chair, on which he was himself to be seated, with his bottle before him, and quite at his ease.

Harry was curious to see these sights: he told Lucy that here would be fine examples of all they had been saying about the centre of gravity. These wonderful things must be done from understanding how to manage that properly. He wished more and more, the longer he thought of this, to see these tumblers. Lucy, it must be confessed, was not so curious on this subject, and she would much rather, had she been to choose, see the new Corsican fairy.

Their father and mother had determined to sleep at the inn where they now were, and they told Harry and Lucy that they would, in the evening, let them see ei-

ther the Corsican fairy or the tumblers, but to both they could not take them, as they were in opposite parts of the town: the tumblers at the theatre, the Corsican fairy to be seen at the courthouse, between the acts of a concert. Lucy was fond of music, Harry did not care for it.

"Well, Harry and Lucy, which do you choose?" said their father. "Take five minutes to consider; but then you must decide, that we may engage our places or buy our tickets in time."

Lucy recollected the resolution she had made when first she set out upon this journey, that she would imitate her mother's kindness, of which she had seen so many examples; she therefore gave up generously her own wish to hear the concert and see the fairy; she did this in so kind a manner, that she put her brother quite at ease. She was very happy with him seeing the tumblers, and when it was all over, she was quite content with them and with herself.

At the end of the next day's journey our travellers arrived at Clifton. Harry and Lucy were delighted with the place, and were glad to learn that they were to spend some days here, in order that their mother might rest herself. The next morning after their arrival they walked with their father on the Downs, from the top of which they looked down a steep cliff, and saw the river Avon below. They descended to the river, down the cliff, by a new road, which a number of workmen were then making. The workmen were breaking some hollow stones, which had fallen out of the bank by the side of the road. The hollows of these stones were lined with shining crystals. Lucy picked up bits of this stone, and added them to the collection which she had made at Matlock. The stone that sparkled with crystals was called, she was told, Bristol stone, and the crystals themselves were called Bristol diamonds. Lucy afterward saw, at the house of a lady in Clifton, a cross of these Bristol diamonds, and another cross of real diamonds; and on laying the two side by side, she could scarcely tell the difference.

They had now descended to the bank of the river, where they stood some time to admire the cliff called St. Vincent's rock. They then walked to view an extensive quarry, where some miners were blasting the rocks with gunpowder. They inquired of the head

workman to what use the stone was applied. He showed them some of it which had been hewn into blocks, and was intended for paving the streets of Bath and Bristol. The chippings were not thrown away as useless, but were, after being broken very small, employed to mend the roads. The rock was limestone; Harry saw some of it burning in a kiln, by which it was converted into white lime.

"The lime burnt at our kilns," said their conductor, "is very much sought after in this neighbourhood, not only for building, but also in these new sugarhouses."

"Is lime used in sugar-making?" said Harry.

"Oh! are there sugarhouses in England?" said Lucy. "I thought sugar came from the West Indies."

"Yes, brown sugar does, but it is purified or refined after it comes to England," said her father; "and at Bristol there are some large establishments for this purpose."

They now continued their walk till they came to the Wet Docks of Bristol. The Wet Docks are a basin of water, formed by throwing floodgates across the ancient bed of the Avon, the river itself being turned into an artificial channel. The water within the basin is prevented by the floodgates from falling with the tide, so that the ships are kept constantly afloat, even at low water.

Our party found the basin crowded with ships from different parts of the world. They easily distinguished those arrived from the West Indies, by the hogsheads of raw sugar that the crews were hoisting out. Harry observed, in a warehouse, as he walked along, the parts of a machine which his father told him belonged to a rolling-mill, which was to be sent to the West Indies for squeezing sugarcanes, along with pans of iron and copper for boiling the juice.

They returned to Clifton, much delighted with all they had seen.

The following morning, at breakfast, as Lucy helped herself to sugar, she asked her mother if she knew that there were sugar manufactories at Bristol; and, added she, "Papa told us yesterday, mamma, that perhaps he would take us to see them."

"Yes, my dear, and he has just obtained permission for you to see them this morning," said her mother.

"Are we to go there to-day? Delightful!"

"But before we go, my dear children," said their father, "I should like to hear whether you already know any thing about sugar-making."

Harry and Lucy said that they had read in "Edwards's West Indies" an account of the sugar-plantations in Jamaica, of the sugarcanes and sugar-mills. Lucy recollected that the sugarcane is a sort of straw-coloured, jointed reed, about the thickness of the handle of an umbrella; that it grows in general to about the height of a man, and has at its top leaves like flags; that the canes are cut in autumn, and that the sugar-making time is a season of gladness and festivity to man and beast, especially to the poor negroes who work in the plantations.

Here Lucy was near going off far away from sugar-making, to talk of the poor negroes; but her father called her back again, by the question of "What is to be done to the sugarcanes after they are cut?"

"They are tied in small bundles," said Lucy, "and carried to the mill, where the sugar-juice is to be squeezed out of them." Lucy looked to Harry for assistance when she came to the mill.

"It consists," said Harry, "of three large iron rollers, turned by wind, or water, or horses, or oxen, or perhaps now the people may have learned to work them with steam. The bundles of cane are passed between the rollers, and squeezed again and again, till all the juice is pressed out. It is caught in a wooden gutter, which carries it into the house where it is to be boiled. It is said to be of great consequence to boil it as quickly as possible, but I do not know the reason."

"The reason is, lest it should ferment," said her father.

"Ferment, papa! I know from old dear 'Conversations on Chymistry' what fermenting is; besides, I have seen beer fermenting. But what harm does fermenting do to sugar?"

"When it ferments it ceases to be sugar. Do you know for what purpose it is boiled, Lucy?"

"That the water which is in the juice may evaporate," replied Lucy, "and that the sugar, as it cools, may crystallize, just as we saw the crystallizing of the alum for my basket."

"True, my dear," said her father. "The juice contains two sweet substances, sugar, which crystallizes

easily, and molasses, which does not crystallize. The boiling is also necessary to separate the sugar from the molasses and other substances contained in the juice. The great object is to obtain the sugar as pure as possible. Much is wasted by being over-heated, by which it loses the power of crystallizing, and is converted into a substance resembling molasses."

"I have often burnt a piece of sugar in a candle," said Harry: "when burnt it remains sweet; but it becomes brown, soft, and sticky."

"The same change takes place," said his father, "where a strong solution of sugar is heated in a vessel over the fire. When only a little hotter than boiling water, it begins to undergo this change, so that a part of it loses the property of crystallizing on cooling, therefore great care is necessary in applying the right quantity of heat, neither too much nor too little. The manner of doing this in the West Indies is still very imperfect."

Harry and Lucy were sorry to learn that so much of the sugar, raised by the hard toil of the poor negro, is spoiled: they hoped that the sugar boiled in England was not so wasted.

"Much of the sugar refined in this country was formerly wasted in the same manner," said their father; "but, in consequence of late improvements, that is no longer the case!"

"What improvements!" cried Harry.

"They are what we are going to see this very morning," said his father. "The new process of refining sugar is what is used in the sugarhouse to which we are going. Do you know what substances are used in the refining of sugar?"

Harry said that he had heard that bullock's blood was made use of; but in what manner, and for what purpose it was applied, he did not know.

"To clarify it," said his father. "When brown sugar has been dissolved in water, bullock's blood is mixed with it when cold; the blood coagulates on the application of moderate heat, and rises in the form of scum, which is then removed from the surface. But it has been found that much sugar is lost by being mixed with the scum, from which it cannot afterward be separated. This way of clarifying is not used in the sugarhouse we are going to see."

"I am glad that we are not to see the bullock's blood," said Lucy, making a face expressive of disgust. "Do you remember, Harry, about *claying* sugar: the accident by which it was found out that clay was good for sugar—good for whitening sugar, I mean?"

"I do not recollect," said Harry.

"So much the better," said Lucy, "for I shall have the pleasure of telling it to you. It is a very curious thing about a hen."

"Tell it to us, my dear Lucy, I advise you," said her mother, "without raising our expectations, lest it should disappoint us afterward."

"Then you must know, mamma, that one day a hen, after walking in some wet place, had clay sticking to the bottom of her feet, and she happened to tread on the top of a pot of sugar; and it was soon afterward observed that the sugar beneath the marks of her footsteps was whiter than elsewhere. From observing this, and considering how it had happened, people thought of using clay to whiten sugar."

"Very ingenious," said Harry, "and Lucy remembered it well, just at the right time for us, did not she, mamma? I had quite forgotten it, but I recollect it all now. The sugar is put into a vessel of the shape of a sugarloaf, which is placed on its narrow end. Then clay, moistened with water, is put over the top of the sugar, and by degrees the water oozes very slowly down through the sugar, mixing in its way with the molasses, which it dilutes and carries along with it. I forget to tell you that there is a hole at the bottom of the vessel. That hole is stopped at first by a plug, but afterward a man takes out the plug, and lets the stuff run off that has oozed to the bottom."

"So men learned from the hen to clay sugar," said Lucy. "When next I see very white sugar, I shall say to myself, Thank you for this, Mrs. Hen."

"You will be doing Mrs. Hen far more honour than she deserves," replied her father; "for in the sugarhouse that we are going to visit, the operation of *claying* is laid aside. The art of refining, as now practised, is a discovery; and it has arisen, not from mere lucky accident, but from judiciously combining sound scientific principles with accurate observation."

"How is that?" said Harry, drawing closer, and listening with great eagerness.

"You know already," said his father, "how brown sugar is extracted from raw cane-juice, now we are to learn how it is made white, and hard, and crystalline, like that which you see every day. Brown sugar, as I have already told you, consists of two sweet substances, *sugar*, forming small crystals, and *molasses*. Molasses is combined with a dark colouring matter, which makes the sugar brown. To get rid of this is the thing to be done. Now if a small quantity of water be added to a mixture of molasses and sugar, the whole of the molasses will be rendered fluid, but only a small portion of the sugar."

"Then," said Harry, "by putting this mixture into a mould, such as they use in claying, they would be able to free the sugar from the molasses."

"From a large portion of it," said his father. "Now, perhaps, if I state to you a few facts, put them in proper order for you to consider, and then ask you a few questions, you may be able to invent for yourself the principle at least of the new improvements."

"Oh, pray try whether Harry can, papa," said Lucy.

"There is nothing I like better than to learn in that way," said Harry.

"Pray help us when we cannot get on," said Lucy.

"Then, to help you on one step," said their father, "I must tell you, in the first place, that the *small* crystals alone of brown sugar are what are freed from molasses by this process. Before the *large* crystals can be purified they must be completely dissolved in water. When liquid, the colouring matter can be separated from the sugar. Now can either of you tell me how the separation is made?"

"I know that alum is used by the diers to separate colours from liquids," said Lucy.

"Very true, Lucy," said her father.

"But I do not know why," said Lucy.

"Because alum contains an earth which has the property of attracting colours to itself. Also charcoal made of bones is sometimes employed for the same purpose. As soon as the colour is completely separated from the sirup by these means, the liquor is put into a filter, and whatever runs through is pure sugar and water, from which the water must be evaporated. How?"

"I know, papa," said Lucy, "from what you before

told us, that the sirup must not be heated in a vessel over the plain fire; yet, in what manner to boil away the water, if not over a fire, I cannot imagine."

But after considering a little, she added, "Perhaps it might be boiled, as they sometimes do things in the kitchen, by steam, and then they are never burnt."

"That is well thought of," said her father.

"But then there is such a quantity of this sugar," said Lucy, "it would require such monstrously large vessels, that I do not know how they could be well heated by steam."

"Some great buildings are heated by steam," said Harry; "so let the vessels required be ever so large, it might be done. It would be easy, would not it, papa, to conduct steam through pipes under the great pan that holds the sugar."

"You are both of you on the right road," said their father. "But something more must be thought of. By the method you have suggested we might heat the sugar, but not boil it: a solution of sugar, if in an open vessel, requires a stronger heat to make it boil than water does."

"I should think," said Harry, "that by confining the steam, it could be made much hotter than boiling water, and then with the confined, compressed steam we might boil sirup, might not we?"

"You might," said his father; "and some persons do boil sugar in this way; still there is some risk of overheating the sugar; therefore think of some better way. Instead of raising the temperature of the steam, consider whether you know of any means of making fluids boil without increasing the heat."

Harry considered for some time, and at length said, "I have seen water made to boil when only moderately warm, by putting it under the receiver of an airpump."

"How did that happen?" said his father.

"Because there was a vacuum," said Harry, "there was no pressure of the atmosphere. If we could place the sugar-pan under the receiver of an airpump, that perhaps might do; but the quantity of sugar to be boiled puzzles me, father; the sugar-vessels are very large, I believe. I could only boil a very small quantity in an airpump; so that, after all, it would not do, I suppose."

"Why will not it do?" said his father. "Till you

are sure that what you propose will not answer, never fly off to any thing else. Do not give up your ideas too hastily. You should not fix your imagination upon the particular receiver of the airpump you have seen. To be sure, you could not conjure a sugar-boiler into that small receiver."

"No, to be sure," said Harry, laughing; then becoming quite grave again, he went on thinking. "How shall I manage it? It is impossible to blow a glass large enough for the receiver."

"Why do you stick to the notion of a glass receiver, Harry?" said his father. "Do you think it essential to the having a vacuum, that it should be produced in glass?"

"Certainly not," said Harry, "it is not necessary by any means. I only thought of the glass one because that was the only receiver I had seen; but I perceive that any other substance that is airtight will do as well as glass. How foolish I am! I remember now the pump, and the steam-engine, where the vacuum is large enough; or a vessel might be made as large as could be required for the purpose."

"Now you have it, Harry. The sugar is boiled in a vacuum, and that vacuum is produced by means of an airpump. The exact details I do not know, having never seen it done myself; but I hope we shall see it to-day, and so now let us set out."

The sugarhouse which Harry and Lucy went to see, was a large building of eight stories high. The first circumstance which struck them on entering it was, that in several spacious rooms through which they passed, and in which the work seemed to be going on, there were not many workmen. Lucy supposed that it was the hour of dinner, as had happened in some other manufactories which they had seen; but she was told that this was not the case; and that all the men who were ever employed in this sugarhouse were now there. Few only were necessary, because so much was done by machinery. In truth, the men seemed of little importance. It appeared as if they were employed only as under-servants to the machines, and to do trifling things, which the mechanic and the chymist had not thought it worth their while to invent the means of effecting in any other way.

The large rooms and passages through which they passed were all warm, as Lucy observed, and yet she could not perceive a fire anywhere. She asked how they were warmed, and was told that she would soon see, as they were going to the place from whence the warmth came. Their guide, the gentleman who was so kind as to show them these works, took them to a building, separate from the rest, in which there was a steam-engine. The fire under its boilers was the only fire used in these works. All the rooms were sufficiently heated by the steam that passed through pipes to the different sugar-vessels.

Harry was here perfectly satisfied, and he looked delighted and proud when he heard how much was performed by one steam-engine. It sent over this vast building equable warmth, and supplied all the water that was wanted in every part of the works. It put in motion a mill for crushing the sugar, and other substances used in refining it; and it kept in unremitting action the pistons of a huge airpump.

They followed their guide into a sort of outhouse, in which the earth of alum was prepared, by adding quicklime to a solution of it.

They then entered that part of the building where the preparatory operations of cleansing the sugar were performed. They saw, in the first place, a few workmen with naked arms, and in light clothing, suited to their hot work, stirring with huge shovels, in a great pan, the raw brown sugar, such as it is when brought from the West Indies: they were stirring it up with a small quantity of water, not sufficient to dissolve it. It looked like treacle. This was afterward poured into earthen moulds, of which there were great numbers in the shape of sugarloaves, such as those of which they had read a description, with a hole at the point, which was turned downwards; and in these moulds it was to be left twenty-four hours to filter. In the course of that time the molasses would pass through into jars beneath the sugarloaf moulds, and the sugar left behind would be in solid lumps, of a light brown colour. Some of the sugar thus purified was put into Lucy's hand; she felt that it was soft enough to be readily crushed. It was now to be dissolved in water, which was heated by having steam passed through it. The earth of alum, which they called *finings*, was then added to this solu-

tion, and thoroughly stirred about by passing currents of steam through it.

This was performed in a great square cistern, which had a double bottom and sides, with a space left between, sufficient to introduce the steam. The inner bottom and sides were perforated with minute holes; and through these holes the steam passed up into the liquid sugar. They heard a rapid succession of explosions, occasioned by the sudden condensation of the steam; and when the solution became hot, they saw immense volumes of steam rising through it. After this, the sirup was allowed to run into the filter. The filter appeared on the outside like a great square chest; and the inside was divided into parallel compartments, by coarse linen cloth, which was stretched over frames of copper. The liquor was admitted into every alternate cell, and was filtered by passing into the cells on either side, which were empty. The sirup flowed out from the filter a transparent fluid, of a pale straw-colour.

They were now conducted to the most remarkable part of the new apparatus, the evaporating pans, in which the water was drawn off from the sirup. These were made with double bottoms, so as to admit steam between the two for heating the sirup; and the pans were covered with domes of copper. These domes communicated with the airpump, the great pistons of which were kept at work by the steam-engine. These served to pump out the air, so as to preserve, as far as possible, a vacuum over the liquid. The perfection of the vacuum was shown by a barometer. The master of the sugarhouse informed them, that it required one hundred degrees less heat to boil sugar in vacuo than in the ordinary method, and that it was accomplished in less than one fifth of the time formerly requisite.

After having been evaporated, the heat of the sugar was brought to a certain temperature, at which it was found most disposed to crystallize. It was then poured into earthen moulds of the form of a sugarloaf, such as were before described, and in these it was allowed to consolidate. It is then of a tolerably white colour, and is purified for the last time by being washed with a solution of the finest white sugar, which is allowed to filter through it. The top and the bottom of the loaves, as being less pure, are then pared off in a turning-lathe, and the loaves are afterward dried in a stove.

Lucy said that before she came to the sugarhouse, she had a general idea, from what she had read and from what her father had told her, that sugar went through several processes of filtering, and boiling, and cooling, and crystallizing, before it could be white; but still she was surprised by seeing the number of the different operations, the size of the vessels, and the power and time necessary. She had not been tired by what she had seen, because she knew beforehand the general purpose, and she had not ben puzzled or anxious.

Harry was delighted at seeing that principle, which he had before so clearly understood, carried into practice with success in such great works.

"I hope you will now acknowledge," said he to Lucy, "that the airpump is of some use in common life, and I hope you are convinced *now* that the airpump is almost as useful as the water-pump."

Lucy acknowledged this; and said that Harry might well triumph for the airpump.

"Think," said Harry, "of its being applied to such different things as making sugar and making ice; and not only employed for boiling quickly, but for freezing quickly. I do not think that Otto Guerick, or Mr. Boyle himself, could have foreseen all the uses that were to be made of their own inventions. I wish they could see all we have been shown this morning."

"So do I," said Lucy; "I wish they could."

"All goes back to that one great principle of the vacuum," said Harry.

The gentleman who had shown them this establishment, and who had, with the greatest patience and politeness, explained every part of the business, was glad to see that he had given pleasure to the young people, and that they had attended to and understood what they had seen and heard. He begged that they would rest themselves before they went away, and showed them into a room where they found refreshments were prepared. He gave a cup of chocolate to Lucy, and another to Harry.

"You must," said he, "taste some of the sugar which has been refined by the process you have just seen."

It was in a black Wedgwood ware basin, which showed its whiteness.

"But father," said Harry, eagerly, "can you tell me who invented the method of applying the airpump so beautifully to this use?"

"I can tell you," said his father; "it was the invention of Edward Howard, brother to the Duke of Norfolk; he was an honour to his family; and I hope," addressing himself to the master of the sugarhouse, "that he has been amply rewarded for his ingenuity by the gentlemen of your profession."

"The fruits have been ample," said the master, "but he did not himself reap them; they are enjoyed by his family. He only just lived to perfect his invention."

The master of the sugarhouse then entered into a statement of the prodigious quantity of sugar saved by adopting the new process. Eight pounds of sugar, he said, were saved in each hundred weight; and he helped Harry to make a calculation of what that amounted to every year upon the total quantity of sugar refined in Great Britain.

Our party having finished their chocolate, thanked their host for his attention, and took their leave of him.

As you go down the hill from Clifton to Bristol, you may see in the city below a number of very high, black-looking buildings, in the shape of huge cones, from which still darker-coloured smoke in thick black billows is continually issuing. Some of these conical-shaped buildings are glasshouses. Lucy remembered her father's having showed her and told her of what glass is made. She recollected the taste of the alkali, of the ashes of weeds, and the touch and sight of the sand. She recollected also the story of the accident by which it is said the making of glass was first discovered; and, above all, she remembered the pleasure that Harry and she had in seeing the *thermometer-man* blowing tubes and bulbs of glass with his blowpipe. She wished very much to see some more glassblowing. Her father took her and her brother one day to a glasshouse. Her first feeling on entering the glasshouse was surprise at the great heat of the furnaces in which the glass was melted, and pity for the men who were obliged to work close to them. But when she observed how much they were at their ease, she by degrees was reassured, and able to be amused. She saw, in the first place, furnaces from which was taken the redhot liquid glass. She was puzzled at first by the workmen calling this *metal*; but

that was only their name for what was in reality, as Harry said, glass. She was much amused by seeing the operations of the glass-blower. First, the blowing of a glass bottle, and of a wineglass. One circumstance in the finishing of the wineglass struck her particularly. When he cut its rim round with a pair of shears, the glass, being as yet soft, yielded under the pressure of the shears, so that the wineglass was no longer quite circular, nor was the rim even. The workman then heated the wineglass again, and dexterously twirling it round, it was brought back to the circular shape, and its rim was even.

Harry's father asked him why this happened.

He said he thought that it was turned into a circular shape by the pressure of the air as it was whirled round while soft, as any other substance is made circular by the pressure of the tool when turning round in a lathe. And he thought that the air withinside of the glass prevented its being driven in and squeezed together by the motion.

His father told him that he was partly right in his supposition; but there was one reason, one cause, to which he had not adverted, and which he had not yet perceived. He would say no more, because, perhaps, by observing further, he would discover it for himself, in attending to another operation—the blowing of window-glass, or *crown* glass, as it is called. First a great pear-shaped bubble of glass, about a foot in diameter, was blown at the end of an iron tube, to which, being soft and hot, it adhered. Then, by rolling the pear-shaped bulb upon a smooth marble table, and blowing into it, and by repeating these operations alternately several times, and by whirling it rapidly round near a hot fire, the bulb was brought from its pear shape into that of a globe. This globe, at the part nearest to the furnace, was the hottest and softest, and yielded most readily to the centrifugal force, as it was whirled round, and therefore it spread out most there, so as to become much thinner than at the part to which the iron tube was fixed. To make the glass of an equal thickness throughout was next to be done. The iron tube was broken off from the glass, leaving a hole in the globe, and then, by means of a little hot glass, the tube was fastened to the opposite thinnest part of the globe, and whirled again. The thickest part being this time near-

est the furnace, became hottest; and in its turn yielded the most, becoming thinner and thinner. As the globe was whirled, the centrifugal force opened more and more the hole which had been left where the iron was broken off, till after some whirling the globe became a large circular plate of flat glass of nearly equal thickness.

Harry now perceived what he had omitted in the case of the drinking-glass: the *centrifugal force*, or that force which arises from the tendency the parts of bodies have to fly from their centre, when turned round rapidly.

As he left the glasshouse, he continued his explanation.

"I suppose, father, that the parts of the soft glass, as they are whirled round, tended to fly from the centre, and by so doing the globe became a larger globe, and the circular plates became larger circles, and all the parts flying off equally from the centre, the rim of the drinking-glass became quite circular."

"It is," said Lucy, "not exactly, but something like a mop. Yes, Harry, a mop. When the maid twirls it round fast, the threads of the mop all fly out as far as they can go from the centre; and if it is a wet mop, out fly circles beyond circles of drops."

"Well," said Harry, "you have made out your likeness to a mop better than I thought you could."

"I remember," continued Lucy, "the first day I ever heard of centrifugal force, or had any idea of what it meant; it was from you, Harry; when I was making a pancake, papa."

"A pancake, my dear! I do not remember your ever making a pancake."

"Perhaps it was a cheese," said Lucy. "Some people, I believe, call it a cheese. Not a cheese or a pancake to eat, papa; but I will show you as soon as we are in mamma's room."

Lucy kept her word, and whirling herself round the moment she was in her mother's room, the skirts of her petticoats flew out, and, as she popped downwards, while they swelled out, she exclaimed—

"There is a pancake, papa, or a cheese, whichever you please; and it is made, Harry, by centrifugal force, is not it?"

"I have been very much amused," continued Lucy, "seeing the glass-blowing. Were not you, Harry?"

"Very much, indeed; and it has left a great deal to think of, and to inquire more about," said Harry.

"What more?" said Lucy.

"A great deal," repeated Harry. "For one thing, annealing, I do not understand that."

"I recollect," said Lucy, "that when the man had twirled the wineglass round, and finished it, a boy came with a long pair of tongs, and seizing the glass, ran away with it, as our man said, to the annealing furnace to be *annealed*. And when I asked what that was, and what was to be done more to it, the man showed me a pan in an oven, and I saw our wineglass, with many others, put into it to be heated again, and then to be left to cool slowly. The man told me they ought to take several days to cool. This was done to make the glass less brittle, he said; this is annealing. What more, Harry, would you know about it?"

"A great deal more, if I could," said Harry. "In the first place, I do not in the least know *why* annealing makes glass less brittle."

"Why? Oh! that is another affair. Why? Nor I," said Lucy.

"And I heard papa and the master-man in the glass-house talking of a curious fact. He said, that 'when a glass vessel, of a particular shape, is allowed to cool immediately after being made, it will often sustain the shock of a pistol bullet, or any other blunt body falling into it from a considerable height; but a small splinter of flint, dropped gently into it, makes it fly to pieces with great violence.'"

"Indeed," said Lucy, "that is very curious."

"So papa said; and they went off to talk about Prince Rupert's drops. Oh, my dear, there are a great many, many more curious things to be known about glass, and all the *whys*, more than in my life perhaps I shall ever know."

"But you need not know all the *whys*," said Lucy.

"But as many as I can," said Harry. "There was a man came in while we were in the glasshouse; did you see him, Lucy?"

"Yes. A gentleman, you mean?"

"I do not know whether he was a gentleman or not," said Harry; "he was a man."

"Do you remember," said Harry, "seeing a great furnace at the glasshouse? You saw only the outside. They could not uncover it to show the inside to anybody, lest they should have let in the cold air. Into that furnace they put the earthen pots full of glass, which had been annealed, and they left them there to set, as they called it. If one of these pots happen to break, it is a terrible difficulty to get it out and put another in its place. The getting out the broken one can be done well enough by a man at arm's-length from the fire, with a long iron hook, or a fork; but the man who is to put in the new pot can have no use of hook or fork; he must put the new pot into its place with his hands, passing them through the flames."

"Then indeed," said Lucy, "you might well call him *brave man*, and *quick*; he must do it as quick as lightning."

"But he could not do it as quick as lightning, or do it at all," said Harry, "without precautions. He must be dressed, my dear, in skins, which are all as wet as possible; and they must cover him all over, all but his eyes; two holes are left for him to see through, but these are defended with thick glasses."

"I am sure I am very much obliged to you, Harry," said Lucy, "for bringing me home such entertaining things. That man, *brave* and *quick*, as you called him, was worth reading all *glass* through to get at. How many pages did you hunt through to find him?"

"I came upon him by accident," said Harry; "but I met with several other things which interested me, and I thought I would bring them away in my head for you; and I have them somewhere there, if I could but recollect them; but I cannot when I *try* in a hurry."

"Do not *try* then," said Lucy. "When I try too hard to remember, I never can recollect what I want, but then it comes all back again when I am thinking of something else. So now, Harry, look at this nice little glass tumbler, which papa bought for mamma's dressing-box, in place of that which I broke. It is prettier than the old one; look at its pretty white leafy border. That is *ground* glass, papa said; and this part below, like crystal, is cut glass; and papa told me how this was done."

"Two of the very things I was trying to recollect," said Harry. "Then I need not tell you about that."

"No," said Lucy. "What a beautiful, transparent,

clear, clean thing glass is," continued she; "and how very useful, and in how many different ways. Drinking-glasses and looking-glasses—you may smile, Harry; but men use looking-glasses as well as women."

"Yes," said Harry, "and for better purposes, too, than looking at themselves. They use looking-glasses, you know, for some astronomical instruments."

"Yes, and for shaving too," said Lucy, "or they would cut their throats. Mighty grand you were about the astronomical instruments!" added she, laughing. "But let me go on my own way in honour of glass, to tell you all that I know. Besides looking-glasses, there are magnifying and diminishing-glasses, both very useful and entertaining; and then spectacles! Oh, Harry! what would grandmamma do without them? and how happy she is with them! reading and working as well as I can, at eighty-six. What a wonderful invention spectacles are, by which people can see so many years longer than they could in former times! Spectacles, I think, Harry, are the most ingenious things people ever made of glass."

"Do not forget telescopes, my dear," said Harry; "the most wonderful of man's inventions."

"How curious it is," said Lucy, "that all these things, spectacles and telescopes, would never have been thought of but for that first bit of glass which the shipwrecked sailors observed when they were boiling their kettle on the sand, with the fire made of seaweed. Do you remember, Harry, my father's telling us that story?"

"I do," said Harry; "and now that puts me in mind of what I wanted to say to you. It was about that story. It is told in the book I was reading to-day, and I was glad to meet with it. There was a little difference; the sailors supported their kettles on the sand with pieces of fossil alkali, nitre, with which their ship had been loaded."

"And in our old story," said Lucy, "the fire was made of weeds, and the alkali came from their ashes, which burnt with the sand, and made glass. There is very little difference in the stories. It all comes to the same thing."

"I know it does," said Harry. "But I was going to say something quite different."

"Say it then, my dear," said Lucy.

"What time did you think that story happened?" said Harry.

"I do not know," said Lucy. "I hardly ever think about *time* in stories. I think it was in former times—a great while ago."

"In the time of Pliny, or before?" said Harry; "he tells the story."

"Very likely," said Lucy. "I do not care who tells it."

"But, my dear," said Harry, "what I want you to care for is the wonder that it should be so long since glass and the way of making it were first discovered by that lucky accident, and yet that it should be hundreds of years before it was brought into common use. You know the ancients, the Greeks and Romans, had not glass as we have."

"I thought that they had glass bottles in old Roman times," said Lucy. "I remember something about a bottle of glass in the Roman history, which a man brought to the Emperor Tiberius (I think), and he dashed it to pieces when he was provoked, and the emperor put him to death for it. Do not you remember, Harry, my reading it loud to mamma, and your being so angry with that tyrant?"

"I remember that perfectly well," said Harry; "but that was only one particular bottle."

"But besides that particular bottle," said Lucy, "I recollect hearing Mr. Frankland tell mamma that there were plates of glass found in the ruins of Herculaneum."

"Did he?" said Harry.

"Yes," said Lucy, "and from that it is supposed that glass windows were used by the ancients."

"Perhaps so," said Harry. "But, my dear Lucy, to go no farther than England, my book says that the English had not glass windows for many hundred years after that. The windows of houses and churches were covered with linen cloth till towards the end of the tenth century."

"You mean till about the year 999!" said Lucy.

"It was not till after the days of Queen Elizabeth," said Harry, "that it was quite common for houses to have glass windows."

"How very stupid people must have been in those former days then," said Lucy.

"So it seems," said Harry; "and yet I suppose they were not naturally more stupid than we are now. Rec-

ollect Virgil and Homer, my dear. But then the ancients had not many men of science."

"And then came the dark ages, as our history calls them," said Lucy; "and in the dark ages I suppose people fell asleep, and could not think of glass, or anything else. Even when they wakened there were not many that could write or read, you know, Harry."

"They had very few books to read," said Harry, "except the ancient Greek and Roman books over again, and they had scarcely any books of experiments, I believe."

"They had only manuscripts," said Lucy, "written on parchment, or on *papyrus*. I remember papa once showed me a papyrus manuscript in a museum, and I saw parchment rolls too, which the ancients called books."

"And what work there must have been making copies enough of those manuscript books," said Harry, "for people to read. And how few copies of books a man could make after all: and he could do nothing else."

"No wonder the people were stupified," said Lucy.

"But then happily was invented the grand art of printing," said Harry.

"Yes, I remember," said Lucy, "seeing it in capital letters in the Memorable Events. And when I first read of it I did not know why so much was said about its being such a grand invention. Now I begin to understand better. By-the-by, Harry, you have seen a printing-press. I never saw one, and I should like to see how they print. I think that my father was asking something about printing-presses in Bristol."

"Yes," said Harry, "he told me that he will take you to see one if he has time."

"I wish it may be to-morrow," said Lucy. "We have very few days more to stay at Clifton: I hope papa will have time to show me the printing-press. But in the meantime, Harry, will you play at cup and ball with me; look what a pretty ivory cup and ball mamma has given me. I thought of it several times while you were talking of glass, but I would not interrupt you. Now let us have a trial on the spike. Which will catch it the oftenest? Will you spin the ball for me?"

"What is the use of spinning it?"

A question easily asked—very difficult to answer.

"MAMMA, I am sorry that you could not go with me to see the printing-press to-day, for it was very entertaining. And look," said Lucy, "I am not covered with printer's ink, as you said I should be."

"If you did not take care, my dear, I said. Did not I?"

"Yes, mamma; but I did take care, you see, for I have not a single spot, and yet I saw every thing perfectly. Mamma, you have seen printing so often, I suppose, that it would be tiresome to describe it to you. And I shall only tell you that it was done almost exactly as is explained in our *Book of Trades*, in the chapter of *The Printer*. Do you remember my reading it to you, mamma? and the picture of the letter-press printer? And at the end it was said that, after reading this, young people should endeavour to go through a printing-office. I asked you directly, mamma, to take me to see one, and you said that you could not then, but that you would some time or other; and now the some-time-or-other, which I thought never would arrive, has come to-day. I saw the letters, or the types, all in their square divisions in their cases, which lay sloping within reach of the compositor, who, with his *composing-stick* in his hand, picked out the letters and placed them in the *form*. Then another man inked their faces with a black puff-ball, and afterward the wet paper was pressed down on them. I knew and understood almost every thing he was going to do mamma, from recollecting the description. This was very pleasant. There was one thing though which I had mistaken; when I took up one of the types, I saw that the letter stands out from the face of the metal, it projects: now I had always fancied that the letters were hollowed out, cut into the types, as the letters for instance of your name, mamma, are cut into this seal."

"How could you think so, Lucy?" said Harry; "you know that would be engraving, that is the way engravings are made."

"Yes, now I recollect, I know that is the way engraving is done, but I thought in printing books it was the same; and I know now what led me into the mistake; it was our little ivory letters, which we put together so as to spell out words; they are all cut *into* the ivory, and filled up with ink."

"But does not your Book of Trades, Lucy, describe how the letters are made?" said her mother.

"No, mamma, not that I recollect," said Lucy. "I dare say the author supposed everybody must know it, but I did not."

"That is my fault, I am afraid," said her mother.

"Not yours, mamma, but the fault of the man, the author of the Book of Trades, if it is anybody's fault. But, indeed, it must be very difficult for great grown-up old authors, to recollect the time when they did not know every thing or any thing themselves, and very tiresome to them to explain every little particular from the very beginning. It must be difficult too for wise authors to guess or conceive the odd sort of little foolish mistakes that children make."

Harry waited till Lucy had done speaking, and then told her that the manner in which letters are made is described in the Book of Trades, under the head *Type-founder*.

"Is it indeed?" said Lucy; "then I read very carelessly. But I remember the calico-printer perfectly well, and how his types, or his blocks and patterns, are made. I know the pattern is first drawn on the block of wood, a leaf and flower for instance, such as there is on this curtain: then with a very sharp knife, or a little chisel, they cut away the wood all round the pattern, and between every part of it, so as to leave *it standing up and standing out*."

"In *relief*," said her mother.

"Then they rub colours on this pattern," said Lucy.

"As the other printer rubs ink on his types," said Harry.

"And the calico-printer stamps it down on the calico."

"Just as the letter-press printer did the paper on the types," said Harry.

"How comes it, Lucy," said her mother, "that you remember so accurately all this calico-printer's business?"

"Oh, mamma! for an excellent reason, which Harry knows. Do not you, Harry?"

"I do," said Harry, smiling.

"Mamma, Harry was a calico-printer once, and printed a blue-starred gown for my doll," said Lucy.

"And a pretty blotted, blurred gown it was," said Harry.

"I liked it the best of all her gowns, and so did she," said Lucy. "And we were so happy doing it, mamma, except when Harry cut his finger hacking at the block," added Lucy, shrinking at the recollection.

"What signified a cut," said Harry; "but I broke the point of my knife, and that was the reason the star was but a botch at last."

"The worst of it was," said Lucy, "that the stars all came out the first time it was washed. But that was not your fault, Harry, but the washerwoman's."

"More probably the fault of the colours you used," said her mother; "or else, why did not the colours wash out your own gowns? the same person washed them."

"That is an unanswerable argument," said Harry.

"Therefore I will not attempt to answer it," said Lucy.

"I am glad of it," said Harry; "I want to go on to something else. Mother, it is very extraordinary that printing should not have been invented for so many hundreds of years."

"The same thing we said about glass," cried Lucy.

"It is surprising that the ancients should not have invented printing, Harry," said his mother, "because they had, in common use, contrivances which might, with a little more thought and ingenuity, have led them to the invention."

"What do you mean, mamma?" said Lucy.

"I think my mother means their seals and their medals," said Harry. "Their seals were made like ours, with letters cut in."

"Yes, in *intaglio*," said his mother. "But how did you know that, Harry?"

"I knew it, mother, from one of the large books of prints which you used to lend me to look at at night, when I was at home."

"Montfaucon?"

"Yes, mamma, there were in that book figures and descriptions of several very large Roman seals, in which there were names in capital letters. I brought you the book one night, mamma, when it was so large and heavy I could hardly hold it, I remember; and asked you to tell me something of those seals, and to read and translate a bit of the description to me, for it was French. And you were so good as to do it, mamma."

"I am very glad I was, since you remember it, and that it is useful to you so long afterward, my dear boy," said his mother.

"It is said that those great seals were used for marking some large earthen vessels, in which the Romans kept their wine. They stamped them down on the clay vessels while the clay was soft, and then it hardened and the letters remained."

"Just like our seals on wax," said Lucy.

"I think, mother," continued Harry, "that all those great seals had the letters cut in, and not in relief."

"Yes, and of all which he gives representations, I think he never found any with the letters in relief; but we are sure that there were such in use among the ancients, for I recollect it is said, that some of the names on those wine-vessels were *cut in* to the clay, that is, in intaglio; which you know is a proof that they were made by a seal or type that was in relief. In the ruins of Pompeii, loaves of bread have been found with letters stamped upon them, and Virgil mentions the branding of cattle."

"Then," said Lucy, "they actually did know how to print, without knowing it. I wonder, when they had such trouble in copying writing, that they never invented a printing-press: how stupid! when they saw the letters on the jars standing before their eyes," continued Lucy; "but, I suppose, that from only seeing one name or a few letters at a time, it never came into their heads."

"Were there any Roman seals ever found, do you know, mother," said Harry, "of the rare kind, with the letters in relief, in which there was more than one word?"

"Yes, I believe," said his mother, "that the Duke of Richmond has in his collection a seal, on which there are four words, the four names of the Roman to whom it belonged; and this seal belonged, it is thought, not to any emperor or great man, but to some private individual; therefore it is believed that such seals were in common use among the Romans."

"And they never invented printing after all," said Lucy; "the Germans or the Dutch, I believe, invented it."

"And how did they come to it at last, do you know, mother?" said Harry.

"That is disputed, and not yet settled, my dear," said his mother. "Some say the hint was taken from these Roman seals; others, from the seeing the names of saints cut on blocks of wood, under their images. Other people think that the idea was suggested by the seeing the manner in which cards were stamped."

"Indeed!" said Lucy. "But those were from wooden blocks, not metal letters, or types."

"True, and the first books were printed from wooden blocks," said her mother. "Some of these are still preserved in public libraries, as curiosities."

"I should like to see one," said Lucy.

"You would see how coarse they were, and how inferior to our improved printing."

"To be sure, from these clumsy wooden blocks," said Harry; "but I suppose they soon got rid of those."

"The Chinese use wooden blocks still, I believe," said his mother; "and it is said they had the art of printing long before it was known in Europe."

"More shame then for them," said Lucy, "since they have not improved it all this time. What! use wooden blocks still. What blockheads."

"Gently, gently," said her mother. "There may be some reasons for this, which you do not know: they have not our alphabet."

"But without going off to defend or attack the Chinese, let us go on with our own affairs," said Harry. "What came next, mamma; and how did the people get to the printing-press?"

"The first improvement made after the printing whole words with wooden blocks, was the making moveable letters; then the same letters could be used over and over again, and as many made as they pleased. These were first of wood, afterward they tried metal; and when they had moveable types of metal, they next found the readiest way of fixing these in frames, and of inking and stamping a heavy weight down upon the paper, which was laid over them. There was the printing-press."

"What was the name of the man who first made a printing-press?" said Lucy.

"That is disputed too," said her mother. "Some say a man of the name of Scheffer, a servant of a Dr. Faustus, and some say Faustus. Poor Dr. Faustus should be allowed the glory of the invention, as it brought him into some difficulties."

"Difficulties! how, mamma, such a great convenience as the art of printing?" said Lucy.

"When he carried a parcel of his printed Bibles from Germany to Paris, and offered them for sale, as manuscripts had formerly been sold, the French, considering the number of copies he had made, and finding them all to a letter the same, which was a degree of exactness beyond what any the best copyist could have accomplished, suspected that he was a wicked magician, and, by threatening to pursue him as such, and to burn him, they extorted his secret from him."

"How cruel!" cried Lucy.

"How unjust!" exclaimed Harry. "I would never have told it to them."

"I would rather have told it than have been burnt alive," said Lucy.

"It is very happy for us that we do not live in those days of ignorance," said their mother. "Men are honoured for inventions now, not persecuted or burnt."

"That is a blessing," said Harry. "But, mother, how much you know about printing, and printers, and printing-presses, and all the history of the invention: how could you remember it all, and have it ready for us the very moment we wanted?"

"Very easily, my dear," said his mother, smiling. "Shall I tell you how and why? When you went with your father this morning to see the printing-press, as I could not go with you, lying on my sofa here, I read an account of printing; for I was determined to be as wise as you by the time you came back."

"And a great deal wiser, mamma," said Lucy.

"A great deal, because you picked out all the things I did not know, and wanted to know," said Harry. "Thank you, mother."

His mother asked Harry if he had found out whether there was in Bristol any printing-press moved by a steam-engine: Harry answered, that he did not know.

"You do not know! but did not you put your father in mind to inquire?" said his mother.

"No, I did not," said Harry.

"That is very odd," said Lucy, "you who never forget any thing of that sort."

"It was unlike you, indeed, Harry," said his mother, "you were so intent upon it yesterday. I recollect your surprise and admiration when your father told you

of the double printing-press, moved by a steam-engine, which he had seen in London, where, without hands, the types are pressed against the paper, and the ink spread just in the quantity required over the letters; and which can in one hour print 900 sheets on both sides. My dear Harry, is it possible you can have forgotten this?"

"No, mother; I never said I had forgotten it," answered Harry.

"Then why did not you put your father in mind to inquire whether there was any such printing-press in Bristol? When you left me, your head seemed quite full of it."

"Yes, mother—but—"

"But what? pray tell me, for I cannot understand your silence, my dear," said his mother.

"Only I thought, mother, that Lucy would like better to see the plain common printing-press first; because she said that she should like so very much to see exactly what is described in the Book of Trades. Therefore I did not ask papa about the steam double printing-press, because I thought that would puzzle and hurry her, and that she would not see the thing just as she wished; and you know I can see what I want another time perhaps."

"How very kind, Harry," said Lucy. "So that was your reason, and you did not forget? But you never told me that you gave it all up for me. If mamma had not by accident asked, I should never have known. Oh! Harry, why did not you tell me?"

"What signifies telling or talking about it," said Harry. "It was nothing but just what you would do for me. I do not forget the fairy you gave up for me, Lucy, the other day, the new Corsican fairy!"

"A STEAMBOAT will set off from Bristol to-morrow morning! Oh, father," cried Harry, "can you take me to see it?"

"I can, Harry, and will with pleasure," said his father.

"And Lucy?" said Harry, in a tone which showed that his joy, great as it was, could not be complete without her.

"And Lucy," said her father, "if the day be fine; but I cannot take her if it should rain."

Next morning Harry was up by daybreak, peeping out to see what kind of a day it was likely to be. A cloudy morning it was, at five o'clock; threatening rain desperately between six and seven; raining downright between eight and nine; and presently, it not only rained, but it poured so that all hope was over for Lucy. Splish! splash! Harry trudged after his father through the dirty streets, scarcely hearing, not at all heeding, the rattling of carriages, rumbling of carts, rolling of barrels, jarring and jangling of iron bars dragged upon *drays* without wheels, over rough pavements, with all the indescribable clatter, and clangour, and clamour, and stunning din, of this most noisy of noisy cities. Nor did he feel the rain which poured over him. But when the heavy shower ceased, and when dripping umbrellas closed, and the sun, through the clouds, gave promise of a better day, Harry entreated his father to let him run back for Lucy. If his father would but wait for him five minutes, in a shop—"this bookseller's shop, papa, I will be back in less than five minutes, and I will bring her very quickly, and as safe as possible, through the streets; may I, papa?"

"No," his father said, he could not wait, for the vessel would set off punctually at the appointed hour, and if they delayed five minutes they should be too late. Then Harry thought they could never walk fast enough. On he kept, before his father, the rest of the way, till they came to a great crowd of people. Not only the lower class of idlers, but persons of all ranks, assembled to see the departure of the steamboat. Harry darted quickly after his father, while heads and elbows closed over him. He could not see farther than the backs and legs of the people before him for some time; but he pierced through the darkness of the dense crowd of tall bodies, and emerged at last from under the elbow of a six-foot-high sea-captain into full daylight. He found himself standing on the stone pier of a large dock, at the very edge of the water, in the front row of a multitude of spectators, who covered the quay. Through the buzz of voices, the first thing he distinctly heard was—

"*She* will not get out this quarter of an hour—she will not get out till the tide lets them open the dock-gates."

She, as Harry knew, meant the steam-vessel; he rejoiced to find that they were in such good time. Now he had leisure to breathe, and to look about him. Close beneath the stone pier on which he was standing were several vessels, among which he first distinguished the steamboat by the faint gray smoke which he saw rising from a black iron chimney that stood in the middle of its deck. The boat had sails, but they were not spread, they were close furled, as unnecessary for the voyage. It appeared as if there were fewer sailors on board than in the other vessels: but all was in motion on her deck and on the adjoining pier. Two men were rolling a chariot over planks laid from the pier to the edge of the vessel; others were dragging to its right place on the deck another carriage; others held horses on the quay, that were to go into the boat, and which, with ears pointed forward, and expanded nostrils, drew back, and yet in a few instants patiently submitted to their fate: while the gentlemen to whom they belonged, or their servants, anxiously called out, giving directions about their valuable and their favourite horses. Groups of people, with bundles, baskets, boxes, bags, and umbrellas in their hands, stood by, waiting impatiently till the horses and carriages were disposed of; and then they stretched their necks and their hands, and gave in their goods, with eager directions, to a sailor, who, balanced on a board, scarcely appearing even to listen to them, handed the packages, as fast as he received them, to another sailor behind him, repeating continually to the anxious proprietors—

"They will all be safe; all will be taken good care of, *Sir*," or "*Madam*," as the case might be.

Harry was astonished by the vast weight, number, and bulk of things, animate and inanimate, which were stowed on board: loads of boxes, and parcels, and baskets, trunks, chests, or packing-cases, besides the carriages and horses, and, after all, passengers crowding in innumerable. All these to be carried by steam, full against the wind, which was now rising. There was a man in a blue jacket, with a large straw hat on, standing near Harry. He was a sailor, belonging to one of the sailing-packets which lay in the dock, and which was not likely to sail this day, wind not permitting. He eyed, with no friendly eye, these preparations going forward with such alacrity. His brow darkened, and

with a sulky look he began to whistle. One belonging to the steamboat, who heard him, smiled and said—

"No need to whistle for a fair wind. *We* can go without a wind, or against it."

Provoked beyond endurance by this boast, the old sailor swore—yes, I am sorry to say, he did swear—that for his part he would not go on board a steamboat for both the Indies, and a puncheon of rum into the bargain, not he! He would rather, in the roughest gale, be out at sea, in an honest sailing-packet, with a gale in his teeth, than go on board such a thing as this the finest day of the year.

This speech making little impression upon the by-standers, he added, that "It was well for *her* it was fair weather, for she would never stand a gale."

Then shutting one eye, and looking upwards with the other, he observed, that if he was not more mistaken than ever he was in his days, the wind that was rising would soon blow a storm, which would bring, as he prophesied, evil to all who were going on board her.

Among the intended passengers who were standing by was a poor, decent-looking woman, in a black bonnet and cloak, with many bundles in one hand, and holding by the other a sickly-looking little girl. The woman listened with great anxiety, and the child looked exceedingly frightened while this sailor was speaking, and grew paler and paler when he went on telling of the dangerous accidents he had heard of happening on board steamboats—boilers that had burst, and scalded some to death, or blown all on board and the vessel to pieces. The child, on hearing this, let go a cocoanut which she had been hugging close to her bosom, and clung with both her hands to her mother. The cocoanut would have rolled into the water if Harry had not stopped it; but he picked it up, and returned it to the little girl, offering to put it into a bag which her mother tried to open, but her hands trembled so much that she could not untie the strings; Harry disentangled them for her, and begged her not to be alarmed. The sailor persisted in saying that she had good reason to be afraid, adding, that as her child was so much frightened, and as her own heart failed her, she would do much better not to go in the steamboat, but to wait till the next day, and take her place and a comfortable birth in the sailing-packet, which would be off early in the morning.

The poor woman said that she could not wait for the morrow; and though she still trembled, she tried to speak steadily, saying that her heart did not fail her; that she was determined to go now, and in the steam-packet, for it was the cheapest and the quickest way she could go to her mother, who was lying dangerously ill, in Dublin, and if she missed this day, she might never see her mother alive.

The tears rolled down her cheeks as she spoke; the sailor still urged her not to go, and risk drowning her child. Harry called to his father, who was talking to some gentlemen, and had not heard what passed. Harry begged his father would come and tell this poor woman whether he thought she might safely go in the steam-boat or not. Not only his father, but the gentlemen who had been talking to him, came immediately, and assured the poor woman that, in their opinion, she might go with perfect safety. One of these gentlemen was an American; he told her that he had, in his own country, been hundreds of times, and many thousand miles in steam-boats, and had never seen any accident happen.

Harry's father added, further to encourage the poor woman, that the two gentlemen who were speaking to her had themselves taken their passage on board this very packet. She thanked them, and wiping away her tears, said she had been determined to go at all hazards; but now she had no fears. The sailor sulkily turned away and walked off.

A call now came for all to go on board, as the tide served, and they were just opening the dock-gates. All hastened on board except the poor woman; but the moment she began to move, her child screamed, and clinging round her legs, cried, "I know it will burst! I know it will burst! It will scald me to death! It will kill us! Oh, mother! mother! do not go! Oh, mother! mother!" The poor woman did all she could to sooth her, but in vain; the child was so terrified that it listened to nothing; and when its hands were loosened from round its mother's knees, and when she tried to lift it up, the little girl caught fast hold of Harry's arm, struggling with all her might; a messenger came, saying that the captain would not wait; the woman again trembled excessively, and grew pale.

"Perhaps, father," said Harry, "if I offer to go on

board, the little girl will come with me when she sees that I am not afraid."

"Try," said his father.

Harry spoke very gently to the child, who stopped crying, and listened to him, and let him lead her on, when she saw that he was not afraid. He thus got her into the boat to the woman's satisfaction. The child still held fast hold of his hand, saying, "Do not leave me, do not go."

"I must go," said Harry, "and I am very sorry for it, for I should like to stay very much."

His father, who had followed him, and who had learned that they could go a few miles down the river, and be put on shore at a landing-place, told Harry that, since he wished so much to go, he might, and that he would accompany him. Harry thanked him, and was delighted. The gates were now opened, and they were slowly towed out of the dock, and between the narrow piers, while the swing-bridges, turned back, were covered with spectators. A band of music, stationed on the deck, played. The sun shone bright, and all looked happy. Yet Harry was a little disappointed by their being towed. He told his father that he had thought it was all to be done by steam.

"Wait a few minutes, and you will see that it will be so," said the captain, smiling.

As soon as the vessel had reached the river, and passed the place where a ferry-boat was crossing, the smoke from the chimney issued thicker and thicker, and spread like a gigantic pennon over their heads. The towing had ceased, the paddle-wheels were set in motion, "And now, my boy," said the captain, "we are going by steam." And easily and swiftly they went, gliding rapidly on between high hills and rocks on both sides of them. The lofty crescents, terraces, and hanging gardens of Clifton, seemed to fly back as they passed. In a few seconds the ferry-boat lessened and vanished. They passed the majestic rock of St. Vincent, crowned with specks of human figures. Birds hovered round their nests in the rock. As they passed on, the captain pointed to Leigh Woods and Nightingale Valley; but scarcely had he named them when new scenes were before them. Harry felt afraid that they were going too swiftly, and that his pleasure would too soon be at an end. He had never stirred from the spot where he

stood when he had first entered the boat; the child, having fast hold of his forefinger, had by this time, lulled by the music and the easy motion, fallen fast asleep, with her head in her mother's lap. Harry longed to go to his father, who was walking up and down the deck, with the captain and the American gentleman, talking, as he heard every now and then as they passed him, of something entertaining about steamboats. But he thought he could not draw his finger away from the child without wakening it, and the mother looked up piteously in his face once when he offered to move, saying—

"This is the first sleep she has had these three nights. She has been very ill."

"Try if you can put in your finger instead of mine," whispered Harry; and gently unclosing the hand of the sleeping child, he drew out his, and the mother slipped in hers. The hand closed again, the child did not waken, the mother smiled, and Harry, set free, ran off joyfully to his father. He found the gentlemen were eagerly claiming for their several nations the honour of bringing into general use the invention of the steam-vessel.

The captain, who was a Scotchman, claimed it for the men of Glasgow. The American maintained, that the number of steamboats in America, and the years they had been there in use, proved that they had first felt the value of the invention. This could not be denied, the Scotchman admitted; but it must never be forgotten, that the first was sent out to America from Glasgow, and that a Scotchman went out with it, and that the engine was one of Boulton and Watt's; without this it could never have been set a-going.

An Irish gentleman here begged leave to remark, that the experiment of the last winter's trial of them between Dublin and Holyhead had been *undeniably* the most fair and satisfactory ever made, and had established steam-vessels in the three kingdoms. An Englishman who was present, and who was silent till the last, said only that he was content, since none could doubt the original invention was English, and the whole establishment of this glorious and useful discovery in *Europe* was exclusively British. Harry's father, to whom he appealed, had the candour to mention a French gentleman,* who many years ago tried an experiment with

* The Marquis de Jouffroy.

a steamboat on the Rhone at Lyons. By listening to all that was said, Harry learned, in short, the history of this invention. It was first thought of nearly a hundred years ago, by a Mr. Hull, for towing vessels in and out of harbours; but he only made the proposal, not the attempt, and he had no idea of using it in any other manner. The first person who actually placed a steam-engine in a boat, and tried the experiment, was a Mr. Patrick Millar, at Glasgow; the remains of the boat are yet in being, and the Scotch gentleman said he had lately seen them. Several persons in Scotland and England about this time proposed to employ steam-vessels; but they did not come into general use till a model of one was carried from Glasgow to America. Its successful establishment in that country, on the prodigiously extensive lakes and rivers of the new world, proved its practicability, and brought it at last into use in Scotland, England, and Ireland.

Harry was surprised to hear that a hundred years should have passed between the first invention and its being brought into general use, and asked why it had not succeeded at first as well as at last. Several reasons were given: the Scotch captain said that vessels were not originally made strong enough; that the improvements lately adopted in ship-building had rendered it possible to employ a greater power of steam than they could formerly, without danger of destroying the vessel. The Englishman observed that people had been for many years too much occupied in applying the steam-engine to other purposes in England, to think of adapting it to boats. And indeed it was scarcely necessary till now, that commerce has increased so rapidly, and the goods and people to be carried on canals, rivers, and sea are so numerous.

Harry was much obliged to the gentlemen who took the trouble to give these explanations in reply to the questions he had asked, and felt a little proud of being treated so much like a reasonable person. He took care not to interrupt them with more questions, though there were many he wished to ask. But, at the first pause, he whispered to his father, and asked whether it was possible for him to see the machinery of this steam-vessel. He could not see the paddle-wheels, of which he had heard the captain speaking. He wished very much to understand how these were moved by the steam-

engine, and how they worked the ship forward so rapidly and powerfully against the wind, which now blew strong. His father told him that he could not show him the machinery while they were going on, but he would ask the captain to show it to him whenever they stopped, which they were soon to do at a place called Lamplighter's Hall. This was now in sight, and in a few minutes they reached it, and Harry heard an increased sound of the rushing of the steam, which was let out before the vessel could be stopped. The noise of the working of the machinery ceased, the vessel stood still, and a rope was made fast to the shore. Some of the passengers were to be set down here, and others taken up; and during the delay this occasioned, the captain had time to attend to Harry's request. He was a good-natured man, and took pleasure in gratifying, as he said, the boy's laudable curiosity. He showed him how the engine is connected with the paddle-wheels. They looked something like the water-wheels of a mill; and as they turned, and as each vane struck upon the water, he perceived that it urged on the boat like the oars of the boatmen whom he had seen rowing. He asked at what rate they had been moving to-day, and was told, "about eight miles and a half an hour." They had been going against the wind, but with the stream. He asked what is the fastest rate at which steam-vessels can go, and was told by the American gentleman, eleven miles an hour; but in England, as the English gentleman said, ten miles an hour. The Irish gentleman asserted that, during the last two years, the passage from Dublin to Holyhead had always been performed at an *average* rate of about seven miles an hour, and that the mail, which was carried by the steam-packets, had scarcely missed a day, even in the most stormy weather. He asked Harry if he had suffered from seasickness. Harry had never been in a ship, and had never been sick in a boat. The river had been so calm to-day that they had scarcely felt the motion of the vessel.

"Well, some time or other, you will feel what it is, and then you will be thankful to the steam-packet, which at least lessens the time of the suffering, and affords the certainty that it will be over in a given number of hours."

Harry listened to his father and these gentlemen, who spoke of the great advantages to commerce and to soci-

ety from this quick communication between distant countries. Enlarged views opened upon his young intelligent mind, and he exclaimed,

"What a grand invention! I am glad it was made by—"

Englishmen, he was going to say, *Britons* he did say, which word satisfying the Scotch, the Irish, and the Englishman, they all smiled upon him.

"Pray, young gentleman, what do you think of us Americans?" said the American. "We have done more than any of you, I guess. Recollect that we have at the least three hundred steamboats in constant use."

"Three hundred!" said Harry, with a tone of admiration. "But recollect," added he, "that it is by our help that you have all these. You know we sent the first model to America."

"We Scotch," interposed the Scotchman, in a low voice.

"That model helped, I acknowledge," said the American.

"Then," added Harry, "if we helped you in the beginning, you that have a whole new world to yourselves will help us in the end, I hope."

"All fair, and I hope we shall; so shake hands," said the American, shaking Harry heartily by the hand. "For one, I promise you, if ever you come to America, my little man, I will make you heartily welcome; and, if you please, you shall go in a steamboat on the Mississippi, and Missouri, and on the Ohio, some thousands of miles. That would please you, I *guess?*"

"I am sure it would," said Harry. Gratitude to these kind gentlemen, and the enthusiasm which had been excited in Harry's mind, quite overcome his habitual taciturnity; he went on talking of this glorious invention. "After a hundred years working at it, it is at last," said he, "brought to perfection."

"Perfection!" repeated his father. "Harry, that is saying too much."

"Too much for any human invention, sir," said the Scotchman. "And, as we know even at present, there is much more to be done *for* these steam-vessels."

"And much is doing," continued Harry's father; "men of science and genius are going on continually making improvements."

"Just before I left London," said the Englishman, "I

heard of a number of capital improvements preparing for our steamboats, which will make them more durable and safer than they are at present."

The American nodded with an air of great satisfaction, and some mystery.

"Can the steamboats be made safer than they are?" said Harry.

"Since accidents have happened," said the captain, "they may happen again; but many that have will hardly occur again. We shall guard against them in future."

"May I ask, sir," said Harry, very respectfully, "might I ask what was the cause of those accidents, and how you guard against them now?"

"You may ask, and welcome, my eager little man," said the captain, with a good-humoured smile; "but I cannot undertake to answer you all this at once, or at any time. Certainly not now, my dear little fellow," added he, looking at his watch, "for I must be off. So good-by to you."*

The poor woman with her child stood close to the place where Harry must pass when he was to land. With a grateful smile, she said to him, as he came near,

* *Extract of a Letter to the Author, from a scientific Friend.*

"In estimating the power of steam-engines and in steamboats, it would be much more in congruity with powers formerly used, and more magnificent in appearance, if the comparison were made with men rather than with horses. Thus a steam-vessel, furnished with two engines, each of fifty horse power, might be stated to have the constitutional force of fourteen hundred rowers.

"I may add, on the subject of steam-engines, that we have several working in Cornwall with cylinders ninety inches (7ft. 6i n.) in diameter, and ten feet clear way for the piston. These dimensions, with steam producing an actual power of ten pounds to the inch, give an effect of 636,170 pounds one foot high, which is about half of a good day's work for a strong man. I am not sure whether either of these engines works double; that is, condenses above as well as below the pistons; there cannot be any reason against their being so worked, and they certainly might make ten double strokes in a minute. Their effect, then, in 24 hours, $24 \times 60 \times 10 \times 2 \times 636,170$ ($= \frac{1}{4}$ a day's work), would be equal to the work of fourteen thousand four hundred (14,400) men; and as one horse is equal to about fourteen men, the engine would equal the work of a thousand horses

"Master, my child here is a deal the better for that sweet sleep she had; thanks to you for it."

Pleased, yet ashamed to have this said to him, in the hearing of several people who were standing by, Harry coloured up to the ears, and answered in a blunt manner, and in a rude tone—

"Do not thank me for nothing. I did nothing at all."

The child, running before him so as to stop him, as he would have pushed on, held up her cocoanut, and said,

"I will give you this. Take it—do."

"Oh no! I cannot take it from you," said Harry, "but thank you, thank you."

The child still held up the cocoanut, and Harry, seeing that she looked vexed by his refusal, took it from her hands, and turning back, rolled it along the deck.

"Run after it; run!" said he; "and thank you as much as if I had it. Good-by."

The child ran after the rolling ball, and Harry sprung from the boat on shore. A chaise was procured at Lamplighter's Hall, an inn near the landing-place, and his father and he were now to go in it back to Clifton. Harry's head was so full of the steamboat, that he could think and talk of nothing else all the way.

"Father, among other advantages which steamboats have over carriages with horses and men, there is this great one, that the steam-engines neither eat, nor drink, nor sleep. And steam never grows tired, but horses and men must rest sometimes."

"I wish you would rest now, Harry, a little," said his father, "and do not kick my shins in your transports."

"I beg your pardon," said Harry. "But, father, I do not see why a steamboat should not go on for weeks and months, just as well as for hours and days. Surely it can go as long as there is fire, and as long as there is water. Cannot it?"

"Surely; as long as we can supply the engine with fuel, and the boiler with water, and as long as the machinery does not break."

"Then, if they make the whole strong enough," said Harry, "why should not people cross the great ocean from England to America, as well as the little sea from England to Ireland? Why not, father? What is the difficulty? You look as if there were some impossibility."

"No, Harry—not an impossibility; but there is a dif-

ficulty, and a great difficulty," said his father; "and, if you consider, you will perceive what it is."

Harry considered, but he did not find it out. His mind was too much exalted; he was too full of the noble steamboat to be able to think with his usual degree of attention.

His father helped him a little to settle his thoughts, and brought him to consider the time which would be requisite for this voyage to America.

"It takes about three weeks, Harry. What would be absolutely necessary to the steamboat to enable it to stay out at sea all that time, and to perform its voyage?"

"Fire, water, men—that is all," said Harry, "except provisions; the usual things which are carried for long voyages, we may take for granted, are carried."

"True; but there is something which you have not yet named that is essential," said his father; "by essential, I mean that without which the thing cannot be."

"Fire, water, men—men, fire, water, repeated Harry. "I can think of nothing else which you could say is essential. I need not say *men* even. One man could regulate the engine, I believe."

"What do you mean by regulate the engine?" said his father.

"I mean," said Harry, "he can supply the boiler with water, and the fire with fuel. Fuel! ay, now I see what you mean, father. Fuel there must be to keep up the fire to boil the water to make the steam. So coals must be carried, or wood, and great quantities; but their weight we need not mind on the water, and with that power of steam, you know, father."

"I know, son; but what will you do about the bulk? Coals, or wood, or whatever fuel be put on board your steamboat, must take up space. Calculate how much."

After going through a calculation, which need not be here repeated, Harry groaned, and acknowledged that, unless the steamboat were many times larger than any that had ever been made, it could not afford space for the necessary quantity of fuel.

"But why," argued he, "should not a vessel be made several times larger than any we have seen?"

A moment's reflection showed him that such increased bulk would require increased strength to keep it togeth-

er, and that again must bring increase of weight, and difficulty of managing the whole.

"Still," said Harry, "though there is this great difficulty about carrying the fuel, we should not give it up, should we, father? Perhaps some of those ingenious men who first thought of steamboats a hundred years ago, or even fifty years ago, imagined they should never succeed: and they were laughed at, were not they, because they did not succeed at first? Yet now! Oh, if they were alive now! and could see what their invention has come to! The admiration of the whole world! Therefore, father, I think people should not mind being laughed at when they know they are right; and they should not be stopped in their great discoveries by little difficulties, or great difficulties, or any sort of difficulties, but still go on trying experiments, and inventing, till they come to some impossibility, and then they must be quiet; but till then, they need not give up, and they should not," cried Harry.

"Right, right, my dear boy," said his father; "I am glad to see this spirit rising in you."

Harry was silent for a mile or two, and then exclaimed—

"Father! I am so glad you have no book this morning to read in the carriage, because you have time to talk to me. Tell me what accidents happened formerly in the steamboats, and how do people prevent them now, as the captain said they can?"

"The principal accidents, and the most dangerous," replied his father, "have been the bursting of boilers. If I recollect rightly, one which burst in an American vessel killed several people, and blew the boat to pieces. Another, which burst in England, scalded to death the persons in the cabin who were near it."

"The sailor spoke truth then," said Harry, "to that poor woman this morning, though I did not believe him. He advised her not to go on board the steamboat, because he said that many such accidents have happened, and happen very often."

"There he was wrong," said Harry's father; "because he exaggerated. But few have occurred. We have accounts of them all, and can therefore judge and speak positively."

"I am glad of it, very glad," cried Harry. "Now, fa-

ther, about the ways of preventing them in future, will you tell me that?"

"First tell me, Harry, do you know the difference between what is called *malleable*, or *wrought iron*, and *cast iron*? You saw both, and the difference was explained to you, when we were at the foundry."

"I recollect it, father," replied Harry. "*Cast iron* is, I believe, that which has been melted and made to run into the form in which it is to be used. *Malleable* or *wrought iron* is that which is hammered, when it is heated, into the shape, whatever it may be, that is required."

"Since you know this much, Harry, I can go on," said his father. "It has been found by many trials that hammered, or wrought iron, is stronger than cast iron, and better able to resist the expansive force of steam. Those boilers of steam-engines which burst were, in almost all instances, made of cast iron. Others of wrought iron have also, in some cases, given way; but even when they have, they have not exploded violently, so as to do mischief. They have rent asunder, and opened, so as to let out the steam. In consequence of this experience, boilers are now generally made of wrought iron. This is one cause of increased safety."

"And a great one," said Harry.

"Another step in improvement and safety has been made," continued his father, "by experience having proved to us that, though copper is rapidly destroyed by alternate heating and cooling, it is more durable than iron for boilers of steam-vessels at sea."

"Copper stronger than iron, father!" cried Harry. "I should never have thought it was."

"You do not repeat with your usual exactness what I told you," said his father. "I did not assert that copper is in all circumstances, and for all purposes, stronger and more durable than iron. I said that it has been found to be more durable when used as the boiler of a steam-engine at *sea*."

"At *sea*!" repeated Harry. "Father, I know that you have some particular reason for being so careful in the words of what you say, and in that emphasis you laid upon sea."

"Find out my reason, then," said his father.

"Perhaps," said Harry, "there may be something in seawater which rusts iron, and so destroys it; and per-

haps *that*, whatever it may be, does not rust and destroy copper."

"Just so, Harry. But what is that something? You are acquainted with it," said his father.

"Is it sea-salt," said Harry, "which is in the water?"

"Yes, Harry; a chymist has lately tried experiments which have ascertained this fact; and, in consequence of these experiments, it has been decided, that in future the boilers should be made of copper."

"How useful it is to try experiments!" said Harry. "That settles what is truth, and there is no more doubting or disputing. That chymist was a sensible man."

"And here is another large instance, Harry," said his father, "in which chymistry has assisted the mechanic."

"True, father," said Harry; "but there is another question I want to ask you, about the paddle-wheels. What were the improvements in them of which those gentlemen were talking?"

"I cannot explain them to you, Harry," said his father, "because you do not know distinctly the difficulties and the faults in the present construction, and these I cannot now describe to you. You should first see them in action in the water."

"And how and when can I do that?" said Harry.

"Not now, when we are going in a carriage on land," said his father, laughing; "but some time or other we may be in a boat within view of a steam-vessel."

Harry, sighing, repeated, "Some time or other. Is there any other great improvement you could explain to me?"

His father yawned, and said he began to be weary of his questions.

"Only one thing more I have to say," said Harry, "and you need not answer. The steam-engine I saw this morning in the boat takes up a great deal of room; if it could be made to do as well in a smaller compass, what a great improvement? How comfortable it would be," said Harry.

"True," said his father; "and how comfortable it would be to me if you would let me rest now."

"Poor father! so I will; thank you. I have quite tired you."

"No, Harry; but I did not sleep well last night. I drank too strong tea or coffee."

His father went to sleep, and Harry sat as still as a

mouse, lest he should waken him. How tea or coffee could keep people awake he did not know; he pondered long on that subject, but was never the wiser; he had never yet been kept awake by either. When the carriage stopped, and not till then, his father wakened, quite refreshed.

When they got out their postillion begged Harry to stay a minute, while he fumbled for something in the side pockets, and then in the front pocket of the carriage.

"It was here. It should be here. They told me it was here," muttered the postillion, while he continued his search with his legs out, and his body in the chaise: at last in the sword-case he found what he had been told was there; and he brought out the cocoanut, which he put into Harry's hands, telling him that a sailor charged him not to forget it. He said that a mother and child sent it to him; and the message was, that "it might make him a cup some time or other; and had good milk in it if he could get it out."

The postillion was anxious to deliver this message correctly; for he said he knew the woman, who had been always very kind to him.

Lucy, who had been looking out of the window of the inn, watching for their return, heard what passed, and saw the cocoanut with joy. She ran to meet Harry, and to learn from him who gave it to him, and to hear an account of his adventures. These he told with all the details she desired, till he came to the moment of the woman's crossing his passage as he left the boat. Then pausing, and turning his cocoanut about in every direction, he said he was ashamed to tell her how crossly he had spoken.

His father added, "Yes, Harry, you are right to be ashamed; I was ashamed for you."

"I wonder you did not tell me so at the time, father," said Harry.

"I knew it would not do you any good at the moment. I thought you would recollect it afterward yourself, as I find you do; and I hope the pain you now feel will prevent you from doing the same sort of thing again."

"I hope it will," said Harry; "but when that kind of feeling comes over me, it is so disagreeable I do not know what I am doing or saying. And I am angry

with myself, and with the people who speak to me, and with every body. But the pain of reproaching myself afterward with having been illnatured is worse still, as I feel now, and I shall remember this, and I will try and conquer myself next time."

"I am sure you will try, and I am sure you will do it," said Lucy.

"Take the cocoanut," said Harry, putting it into her hands. "We will not open it yet. Pack it up somewhere for me."

"Men always talk of packing up a thing *somewhere*," thought Lucy, "and women are to find where."

It required Lucy's best powers of packing to find *a somewhere* for the cocoanut; but she did at last stow it into the carpet-bag, contrary to the prophecies of all beholders.

When they were leaving Bristol, they stopped at a bookseller's to buy some book or books to read in the carriage. Several works were spread upon the counter in the bookseller's shop for them to take their choice. Harry and Lucy read the title-pages of some, which their father and mother allowed them to look over.

"We will dip here and there in the books," said Harry, "and see whether they look entertaining. May we, papa?"

"May we cut the leaves?" said Lucy, peeping between two uncut pages.

The shopman, with some hesitation, presented an ivory cutter to her, telling her that she was welcome to cut the leaves, if she would be so good as to take care not to tear them. He became at ease when he saw her set about the operation, perceiving she was used to it, and dexterous. But care sat on the bookseller's brow, "considerate," when Harry took up the ivory knife: he thought that he would tear away, like most other boys that he had seen, without heeding what mischief they did.

"If I make the least *jag*, I will stop, and show it you, sir; you may depend upon that," said Harry, proudly. "You may trust to our honour. Whoever jags first, stops."

"Very well," said their father, looking up from the book he was reading, "upon that condition you may cut away."

They were glad to see their father and mother both

caught by some new book, sitting down to read. "We shall have good time," said they, "to cut and dip." After each cutting half a volume, they showed the edges of the books. Not the slightest indenture appeared, that could, by the most exact bookseller's eye, be accounted a *jag*. All was smooth and fair, even to the inmost recess of the dangerous corner of the quadruple page.

"Now we have cut enough," said Lucy; "let us dip three times, Harry, and catch what we may."

Harry seized upon one of the books, and opened upon this passage, which he read aloud:—

"As the gloomy habitation my grandfather was in was not to be long endured but from necessity, they were contriving other places of safety for him, particularly one, under a bed which drew out, in a ground floor, in a room of which my mother kept the key. She and the same man worked in the night, making a hole in the earth, after lifting up the boards, which they did by scratching it up with their hands, not to make any noise, till she left not a nail upon her fingers; she helping the man to carry the earth, as they dug it, in a sheet on his back, out at the window into the garden. He then made a box at his own house, large enough for her father to lie, with bed and bedclothes, and bored holes in the boards for air. When all this was finished, for it was long about, she thought herself the happiest creature alive."

"I have heard that before!" cried Lucy. "The Lady Grisell Baillie. Mamma, I heard you reading it last winter to papa. Oh, mamma! do you remember the diverting part about the sheep's head? I will show it to you, Harry; lend me the book for one minute. But this is not the same book you had," continued she; "that was a poem,* and there were notes to it. Here is no poetry! and I am very sorry. I wish I could see again that pretty description of all that Grisell did when she was a young girl. I am sure Harry would like that, though it is poetry."

"Shall I try?" said her mother. "I think I can remember the lines you mean:—

"'And well, with ready hand and heart,
Each task of toilsome duty taking,
Did one dear inmate take her part,
The last asleep, the earliest waking.
Her hands each nightly couch prepared,
And frugal meal on which they fared;
Unfolding spread the servet white,
And decked the board with tankard bright.

* Metrical Legends, by Joanna Baillie.

Through fretted hose, and garment rent,
Her tiny needle deftly went,
Till hateful penury, so graced,
Was scarcely in their dwelling traced.
With rev'rence to the old she clung,
With sweet affection to the young.
To her was crabbed lesson said,
To her the sly petition made,
To her was told each petty care,
To her was lisped the tardy prayer,
What time the urchin, half undressed,
And half asleep, was put to rest.'"

"Thank you, mamma. I *do* like it," said Harry.

"I am glad to see there is something new in these 'Memoirs of Grisell Baillie,'" resumed Lucy, who had been looking over the book. "Here is more than we had in the notes to the poem. Pray, mamma, pray buy this book for the carriage."

"No, my dear, I will not buy it for the carriage," said her mother, laughing; "but I will buy it for myself, if you please, and I will read to you whatever can entertain you."

"Thank you, mamma. Harry, are not you glad we are to have this book?" said Lucy. "Hey, Harry?"

But Harry made no answer; he was intent upon a passage in another book which he had just opened.

"What is it," said Lucy, looking over his shoulder. "Oh, I see the word steam-engine, that is enough for him. But now, Harry, do not choose a stupid book."

"No danger of that, miss. This is one of the Scotch novels," said the shopman.

"A novel, Harry!" said Lucy; "how did a steam-engine get into it?"

"I do not know," said Harry; "but I know that I have found a fine character of—I will not tell you, but you shall hear it. Father, would you be so kind as to read it out to my mother and Lucy?"

"Why should not you be so kind, Harry, as to read it to them yourself?" said his father.

"Because, father, I cannot do justice to it," said Harry; "and it is so good that I could not bear to spoil it. Pray, father, read it. Here is the book."

His father read the following character of the great inventor of the steam-engine:—

"'Amidst this company stood Mr. Watt, the man whose genius discovered the means of multiplying our national resources, to a de-

gree, perhaps, even beyond his own stupendous powers of calculation and combination; bringing the treasures of the abyss to the summit of the earth—giving the feeble arm of man the momentum of the Afrite—commanding manufactures to arise, as the rod of the prophet produced water in the desert—affording the means of dispensing with that time and tide which wait for no man; and of sailing without that wind which defied the commands and threats of Xerxes himself. This potent commander of the elements—this abridger of time and space—this magician, whose cloudy machinery has produced a change in the world, the effects of which, extraordinary as they are, perhaps are only now beginning to be felt, was not only the most refined man of science, the most successful combiner of powers, and calculator of numbers, as adapted to practical purposes—was not only one of the most generally well-informed, but one of the best and kindest of human beings.'"

Several gentlemen, who had been reading, laid down their books to listen to this eloquent and just eulogium. When it was finished, and when the reader's voice stopped, there was silence for a moment—then a general burst of admiration.

"Who wrote it? Where is it? Whose is it?"

All crowded round Harry to look at the book. Harry felt proud of having found out *for* himself, and *by* himself, what was good. It is scarcely necessary to say that his father bought the work. The parcel was made up, put into the carriage, and they drove on. As soon as they were out of the noisy streets, Harry and Lucy seized again upon this book, eager to know if there was any thing more in it about Mr. Watt. They found an account of his powers of pleasing in conversation, and of his great variety of knowledge.

This struck Harry with fresh admiration.

"How I wish papa had known him!" cried Lucy. "Oh, Harry! if you had but seen him! Should not you have liked it very much?"

"I should not have cared for merely seeing him," said Harry, "unless I could have heard him and known him."

They now began to question each other, which of all the great people, of whom they had ever heard or read, they should most wish to have seen and known? And then, which they should have liked only *just to see?* which to have for acquaintance? which for friends? and which they should like to live with always?

These questions brought on a great deal of interesting and diverting discussion, during which papa and mamma were often appealed to, and in which they took their

share, much to Harry and Lucy's delight. The number of those with whom they should choose to live, which at first was prodigious, on Lucy's part especially, was gradually reduced, till at last it came down to very few indeed—not above five or six.

It was observed that Harry, who, in former times, desired to see only great mechanics, now desired to know great chymists too, and all sorts of sensible and *inventing* people, as he said.

This was one good consequence, as Lucy remarked, of their having lately travelled so much. "But to-morrow, Harry," continued she, "is to be the last day's travelling. Are you glad or sorry, Harry? I do not know which I am myself; partly glad, partly sorry, I feel. Sorry that the journey will be at an end, because I like travelling very much, and seeing every day some new and entertaining things and people. But I shall be glad for one great reason to come to the end of our journey, that we may see the cottage by the seaside. I long to know what sort of a looking cottage it is. Do not you, Harry?"

"Yes," said Harry; "but, above all, I wish to see the ocean."

"And the seashore," cried Lucy, "where I may pick up hundreds of shells!"

"And I hope I shall see ships!" said Harry.

"And a boat with sails, in which we may sail sometimes," said Lucy."

"Yes, I should like that very much," said Harry. "I want to know more about sails."

"Shoulder-of-mutton sails especially," cried Lucy; "which I remember reading about in Robinson Crusoe. I wonder what they are?"

Her father sketched for her a shoulder-of-mutton sail, and she was rather disappointed when she learned that the name arose merely from the shape.

The conversation was interrupted by the sight of a boat on a river; but it had no sails—it was a ferry-boat.

At Harry and Lucy's age it was a real pleasure to cross a ferry, though to travellers more advanced in years it may sometimes be a pain, or at least a trouble. They are apt to prefer a bridge.

